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DEPARTMENT OF FORESTS AND WATERS

ANTHRACITE LOSSES AND RESERVES IN PENNSYLVANIA

By

DEVER C. ASHMEAD

UNITED STATES BUREAU OF MINES

TOPOGRAPHIC AND GEOLOGIC SURVEY
BULLETIN M 8
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PENNSYLVANIA
GEOLOGICAL SURVEY
FOURTH SERIES

ANTHRACITE LOSSES AND RESERVES IN PENNSYLVANIA

By Dever C. Ashmead
United States Bureau of Mines

(Published by cooperation with the United States Coal Fact Finding Commission and the United States Bureau of Mines.)

Department of Forests and Waters
R. Y. Stuart, Secretary

Topographic and Geologic Survey
G. H. Ashley, State Geologist

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By R. Y. Stuart
Secretary, Department of Forests and Waters
for the
Commonwealth of Pennsylvania

LETTER OF TRANSMITTAL

R. Y. Stuart, Secretary,
Department of Forests and Waters.

Sir:—

Herewith is a text, with maps, giving the thickness and acreage of each bed in the anthracite field, the percentage of the coal recovered in mining, an explanation of how and why some anthracite is lost, and an estimate of the quantity of anthracite remaining in each bed, and in each of the four fields.

This work was done at the instigation of the United States Coal Fact Finding Commission by Dever C. Ashmead, a mining engineer of the United States Bureau of Mines, and is a companion report to Bituminous Coal Losses and Mining Methods, by James D. Sisler, prepared for the same purpose and published by this Survey in 1924.

Respectfully,
Geo. H. Ashley
State Geologist.

May 20, 1925.

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PREFACE

As part of the general investigation of the coal industry by the U. S. Coal Commission, the Bureau of Mines of the Department of the Interior was requested by C. E. Lesher in charge of the engineering section for the Commission to investigate the waste and losses incurred in the mining of anthracite in Pennsylvania. This investigation was in line with the work specifically authorized by the organic act creating the Bureau, and with the financial assistance of the Coal Commission the Bureau was able to make an extensive study of the subject.

The organization of this investigation by the Bureau of Mines was placed in the immediate charge of the chief mining engineer, George S. Rice. James W. Paul, chief of coal mine investigations for the Bureau, was assigned to act in place of Mr. Rice, who had been detailed to make investigations in Europe.

Dever C. Ashmead, mining engineer, who has in recent years been studying the mining conditions in the anthracite region of Pennsylvania, and until recently was anthracite editor of *Coal Age*, was employed to make the necessary field investigations and prepare a report to the Coal Commission. As a result several conferences with the engineers of the Bureau, an outline of the investigation to be made was adopted, and Mr. Ashmead carried out the details of the plan. He procured the data from 91 of the 244 collieries, these representing 49 per cent of the total production of the anthracite region. The field work consisted of a careful study of the underground workings of representative mines, also of the maps of the various coal beds being mined, and analyses of flow-sheets from the mines and anthracite breakers. In this work Mr. Ashmead received the full cooperation of the operators, their engineering staffs, and the Anthracite Mine Inspectors of the State of Pennsylvania.

M. W. von Bernewitz, mining and metallurgical engineer of the Bureau, rendered assistance in the compilation of the manuscript.

Respectfully submitted,

D. A. LYON, Acting Director,
for H. FOSTER BAIN, Director.

FOREWORD

According to the report made in 1895 by the Second Geological Survey of Pennsylvania, the total anthracite reserves of that State originally were 19,507,872,000 tons; but since the publication of that report the development in the anthracite region has shown additional reserves which justify an increase of the original estimate to a total of 20,770,916,000 tons. Of this latter amount, 4,416,240,000 tons have been mined, leaving a reserve unmined of 16,354,676,600 tons. At the present rate of production of 131,000,000 tons a year (inclusive of losses), this reserve will last for 124 years.

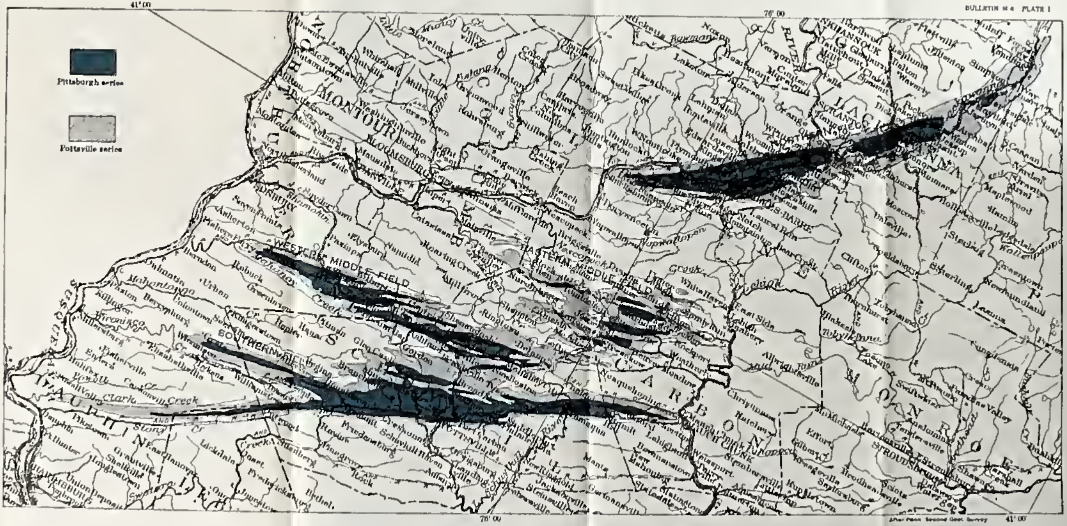
In 1880 the first authentic figures showing the percentage of recovery in mining anthracite gave for certain localities a recovery ranging from 27 to 39 per cent. The Roosevelt Commission in 1902 stated that improvement in the mining and preparation of anthracite would soon make the recovery 50 per cent. This present report for the four principal anthracite fields indicates a recovery of 61.1 per cent, with a total loss of 38.9 per cent, of which 4.3 per cent is in preparation.

Indications are that the recovery in both the mining and preparation of anthracite will become larger, and that a still higher percentage may be expected. This increase, however, may entail the adoption of different methods of mining and a more careful design in construction of breakers for the treatment of the smaller sizes of anthracite.

Attention is directed to that part of the report which deals with the engineering difficulties in the development and operation of the mines, caused by the geographical conditions and the intrusion of water which necessitates raising an average of eleven tons of water per ton of coal throughout the region. These are factors which have a strong bearing upon the recovery of coal, and are a continuous expense whether the mines are operating or are idle.

J. W. PAUL,
Acting Chief Mining Engineer.

COMMONWEALTH OF PENNSYLVANIA
TOPOGRAPHIC AND GEOLOGIC SURVEY
GEORGE H. ASHLEY, STATE GEOLOGIST



After Penn. Second Geol. Survey

MAP OF THE ANTHRACITE FIELDS, PENNSYLVANIA

ANTHRACITE LOSSES AND RESERVES IN PENNSYLVANIA

By Dever C. Ashmead

INTRODUCTION

Geography.

The anthracite fields lie in the northeastern part of Pennsylvania, and were divided by the Pennsylvania Second Geological Survey into four regions, as follows: (1) The Northern Field, consisting of the Wyoming and Lackawanna Valleys in Luzerne County; (2) the Eastern Middle Field in the southern part of Luzerne and northern part of Schuylkill counties; (3) the Western Middle Field in Schuylkill, Columbia, and Northumberland counties; and (4) the Southern Field in Carbon, Schuylkill, and Dauphin counties.

Geology

Northern Field. The Northern Field is approximately 75 miles long and is 5 miles wide at its widest point; it contains 176 square miles. The coal beds lie comparatively flat, particularly in the northeastern part of the field. Here also they are near the surface, and pitch steeply only along the outcrops and near local faults. In this northeastern part of the field the average thickness of the beds is 4.88 feet, and the average depth of workings is 268 feet.[1]* In the middle section of the Northern Field, in the vicinity of Pittston and Wilkes-Barre, the average thickness increases to 5.9 feet,[2] and the depth to 399 feet; and in the southwestern portion of the field the thickness reaches 6.83 feet and the depth 567 feet.[3]

Beginning near Pittston, and generally following the bed of Susquehanna River to the city of Nanticoke, and then passing down the middle of the northern field to its western end, lies what is known as the "Buried Valley" of the Susquehanna River. Here the river once made a gorge 100 to 300 feet deeper than the present river bed, and during the glacial period this gorge was filled with glacial drift. As this drift is water-bearing, considerable care has to be taken in mining the coal beds beneath it. Enough rock cover must be left so that there will be no danger of the mine workings breaking through into the gravel filling of the Buried Valley or into pot-holes. If a break-through should occur, there would be great danger of losing all the underground workings by flooding. This means that the recovery of coal is limited by the support necessary to prevent any breakage of the overlying rocks that would permit the inflow of water and quicksand from the Buried Valley.

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*Numbers refer to bibliography at end of report.

Eastern Middle Field. The geologic structure of the Eastern Middle Field is entirely different from that of the Northern Field; it consists of a number of parallel canoe-shaped troughs. As is implied from the term "canoe-shaped", the basins are long and narrow, and the sides pitch steeply. The beds of coal are much thicker, as is shown by the average of 8.1 feet, but they lie at less depth, the average being only about 347 feet.[4] The Eastern Middle Field contains only about 33 square miles of territory.

Western Middle Field. A basin about 33 miles long and about 5 miles wide at its widest point extends from a point in the vicinity of Delano to the little town of Trevorton at the extreme western end. This basin, known as the Western Middle Field, contains about 94 square miles. In cross-section it resembles two letters UU joined together at a central point, lower than the two sides. This gives practically all conditions of mining from level at the bottom of the Us to vertical along the sides. The beds of coal in this district average 6.5 feet in thickness, and the average depth of workings is 460 feet.[5]

Southern Field. The Southern Field extends from the town of Mauch Chunk nearly 70 miles southwest to Lykens and Dauphin at the two ends of the "fish tail." Practically no mining has been undertaken in a great many years in the point of the field extending in the direction of Dauphin. A cross-section of this field shows very steeply pitching sides, and the rocks between the sides badly faulted and displaced. Warping of the earth's crust in this field greatly contorted the rocks in places, and coal was pulverized by the roof and the floor of a bed moving in opposite directions. In other places the movement and pressure were not so great, and the coal merely runs when it is mined; in still other places the coal is solid. However, along what is known as Sharp Mountain, which borders the southern edge of the field, the percentage of prepared sizes is extremely small, owing to the effect of geological movements. Unfortunately, no data are at hand to show the general thickness of the beds and depth of workings; but generally speaking, the beds in this field lie deeper and are thicker than beds in any of the other fields. This field is the largest of the four, and covers 181 square miles.

Mining Methods.

The physical condition of the beds, as just outlined, determines to a large extent the method of mining which must be employed for the recovery of coal. Where the beds are flat, a room-and-pillar method can be used, similar to that employed in the bituminous coal fields. Where roof conditions permit, long-wall mining can be undertaken. Where the coal does not have much cover it is possible to remove the surface and mine the coal with power shovels. This kind of mining is known as "stripping." Where the beds pitch steeply, the breast system of mining is employed almost exclusively. The present method of breast mining is to drive a gangway in the rock below the coal, drive a rock-chute from the gangway to the bottom of the coal, connect rock-chutes with headings in the coal for the circulation of air, and then, on 50 to 60-foot centers, drive breasts up the pitch, making the breast 18 to 24 feet wide. Timbers are so placed along the sides of the breast as they are driven up that the coal as it is mined falls between the two rows of timbers, and is held from running out the mouth of the breast by a battery. As fast as coal is shot down, coal is drawn from the bottom of the breast through chutes to maintain just enough headroom between the top of the loose coal and the face of the breast to permit the men to work. The spaces between the timbering of the breast and the ribs of the pillars are used for the circulation of air to the face; also as manways for the men to pass to and from their work.

CAUSES OF LOSS AND WASTE

The sources of loss and waste in anthracite mining have been divided into three main parts—namely, (1) geologic; (2) mining; and (3) preparation.

Loss from Geologic Factors

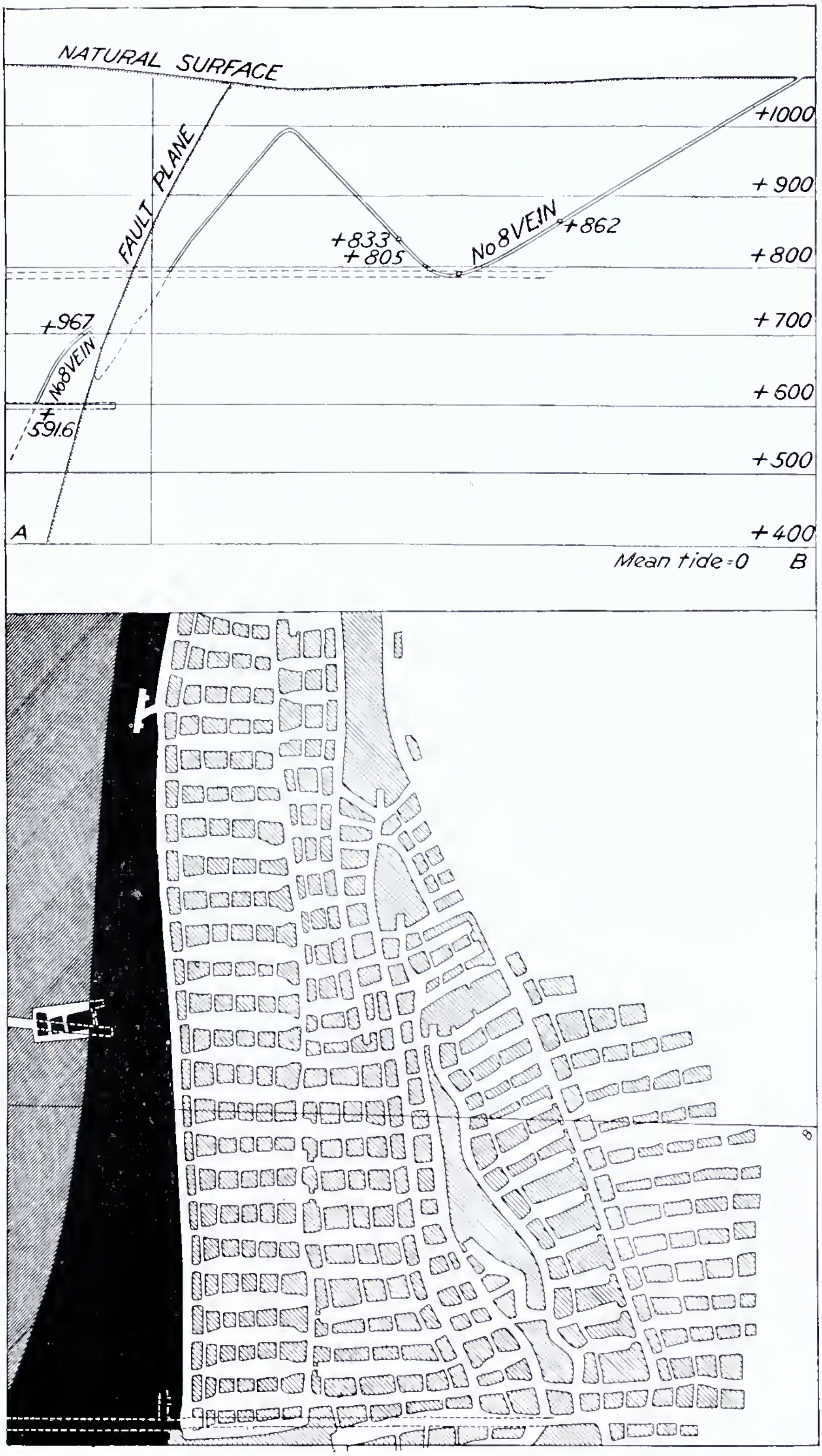
Superimposed beds. As the anthracite region contains a large number (12 to 26) of superimposed coal beds, care must be taken so that the mining of a lower bed does not destroy the value of an upper bed. In general, the practice is first to mine both beds, and then postpone the second mining of the lower bed until the upper bed has been mined out. The pillars are columnated as far as possible, so that undue stresses will not be brought upon the lower bed and start squeezes that will cause loss in recovery. However, where the superimposed coal beds are widely separated, in many places in the anthracite region it has been possible to complete the first and second mining of a lower bed without appreciably affecting the upper bed; but where the beds are close together, it is not possible to do this.

The character of the roof also determines the method of mining a lower bed. A soft roof, and one that breaks easily, probably means that second mining cannot be done in the underlying part of the lower bed until the upper bed is completely exhausted.

Character of roof and floor. Naturally, the kind of rock immediately above or below the coal bed has a considerable influence upon the system of mining that can be established. With a hard sandstone, a much wider chamber or breast can be driven than if the rock is a fireclay, soft shale, or slate. On the character of the roof will depend also the possibility of mining by the longwall system.

Faults. In some places the coal has been broken and displaced by faults, crushed by pressure and movement or removed by erosion. Such areas complicate the mining of the coal and increase the cost by necessity of driving through them to reach good coal lying beyond. Figure 1 shows a fault in the steep-pitching measures in the Western Middle Field, and the area of coal lost. Figure 2 shows some of the difficulties encountered in mining a faulted area.

Figure 1

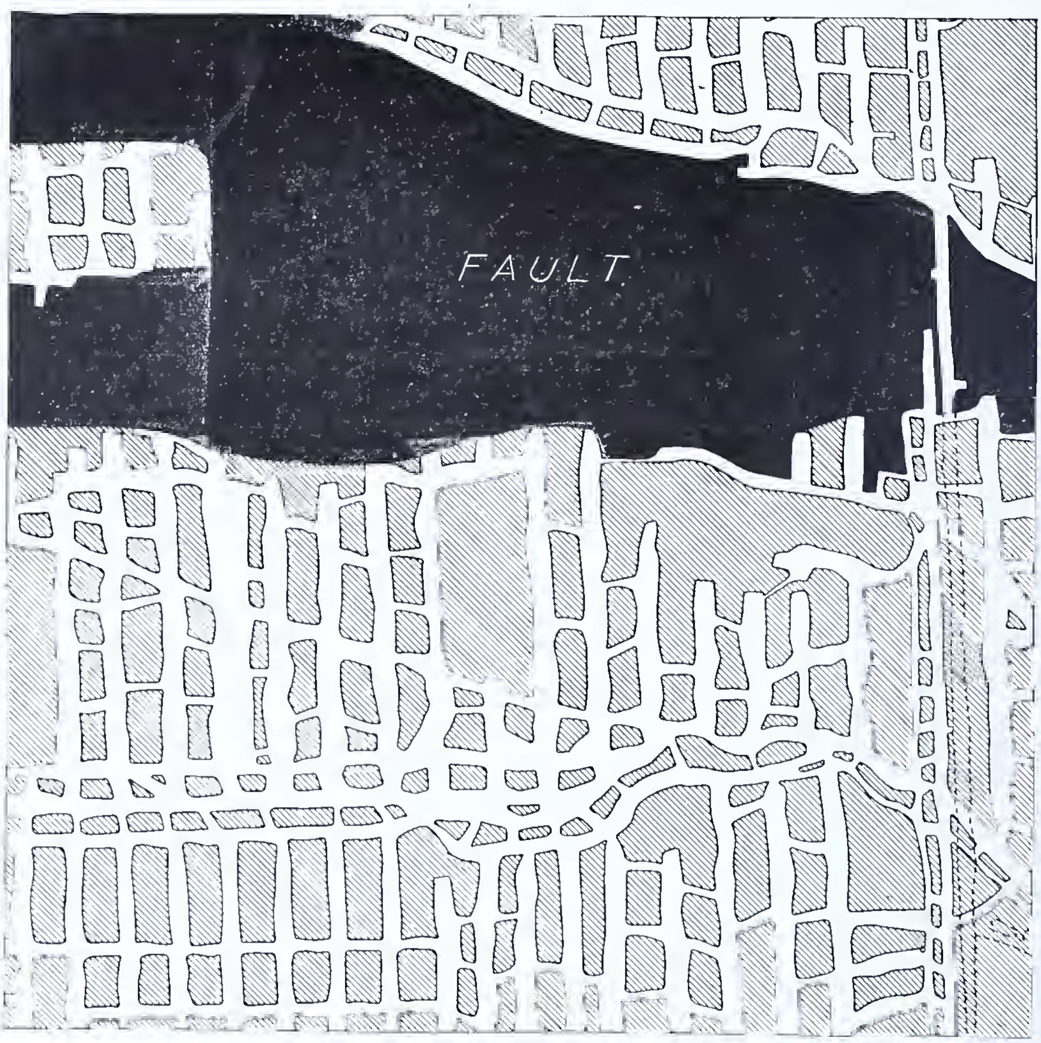


PLAN AND PROFILE OF MINE
Northumberland Co, Pa

Losses due to fault

▨ Virgin Coal
▨ Coal that will be extracted in part or in whole
■ Coal Lost

Figure 2

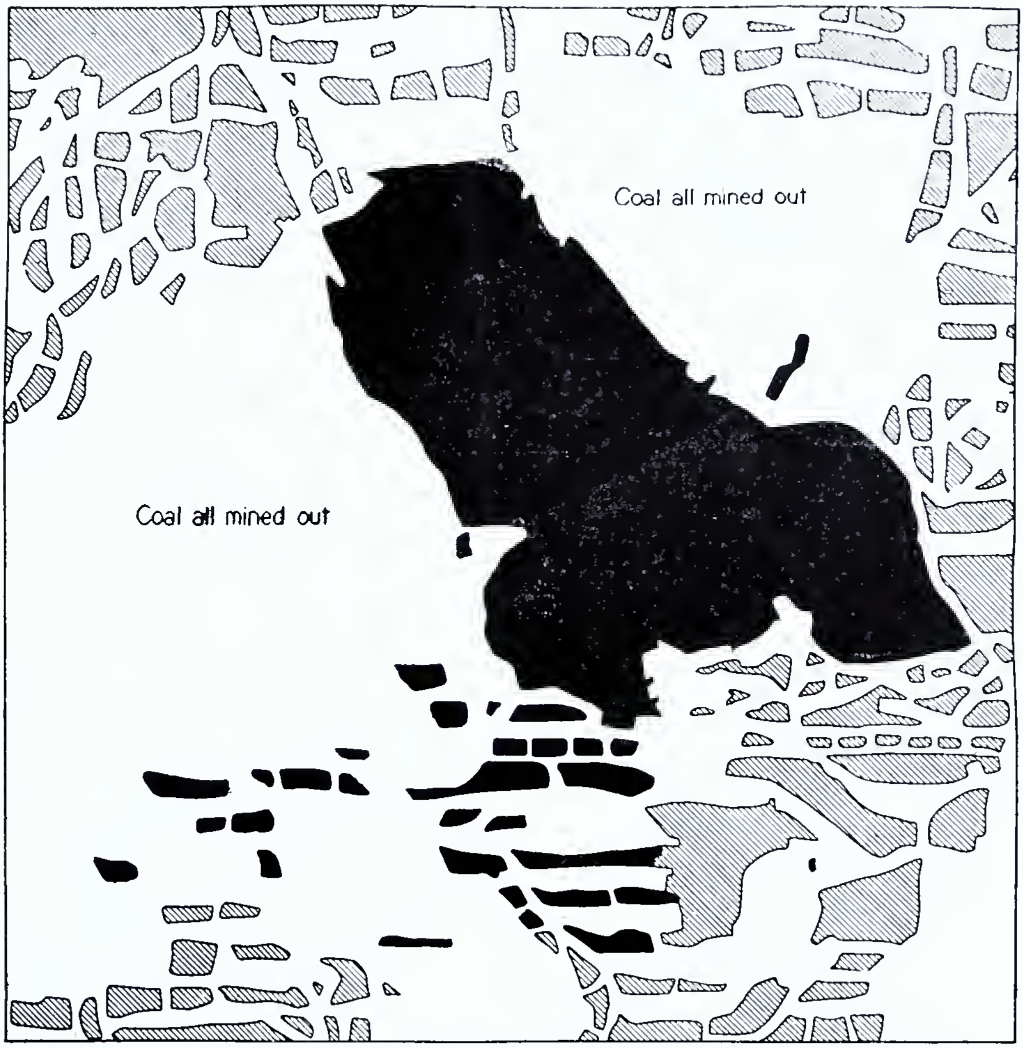


SECTION OF MINE MAP
Luzerne Co. Penn.
Showing coal lost due to a fault

▨ Coal that will be extracted in part or in whole ■ Coal Lost

Thin coal. By unequal pressure, the coal in places was squeezed until it became much thinner than the coal in the remainder of the bed. (See Figure 3). Where the coal is so thin that mining costs become too high for profitable mining, then work must be abandoned. Frequently a considerable amount of mining is done before such an area has been fully proved to be too thin to work.

Figure 3



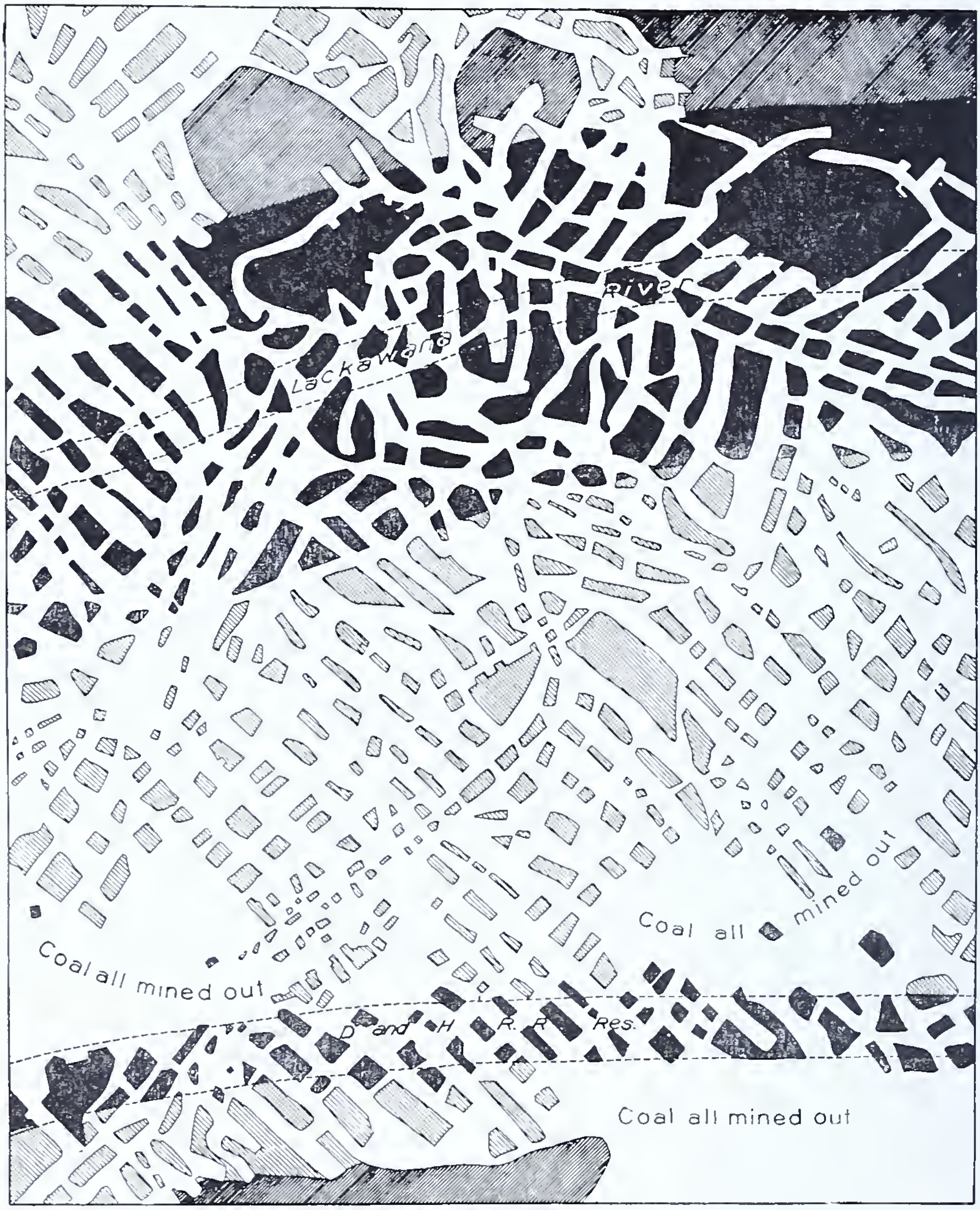
SECTION OF MINE MAP
Luzerne County, Penn.
Showing a block of coal too thin to work

▨ Coal that will be extracted in part or in whole.

■ Coal Lost

Rivers. Where the coal lies under a river, enough pillars must be left so that there will be no danger of breaks in the top rock permitting the river to enter the mine. These pillars (See Figure 4) left to support the river must be considered as an unavoidable loss, for they cannot be recovered.

Figure 4

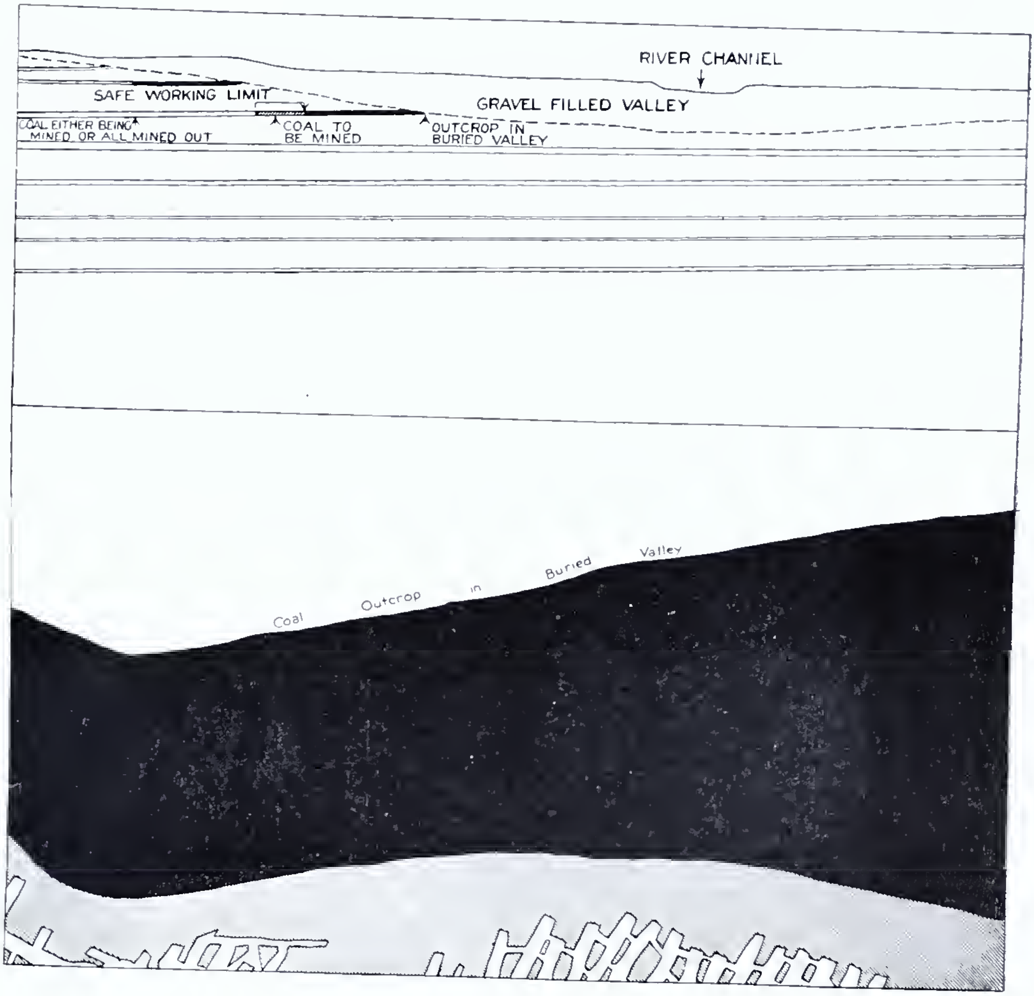


SECTION OF MINE MAP
Lackawanna County Penn
Pillars left in under Lackawanna River and Delaware and Hudson RR (Old workings)

▨ Virgin Coal ▧ Coal that will be extracted in part or in whole ■ Coal Lost

Buried Valley. As previously stated, it is necessary to leave support under the water-bearing glacial drift of the Buried Valley so that the water will not enter the mine from any breakage or caving of the rock. Generally speaking, only first mining can be done in such areas. However, in many places the beds of coal outcrop in the Buried Valley, as is shown in the cross-section of Figure 5. Therefore, a sufficiently strong and wide pillar must be left between the outcrop and the safe mining line so that there will be no danger of any seepage or inrush of water or quicksand. A pillar of his type is shown in the plan of Figure 5, and the safe second mining limit in Figure 6.

Figure 5

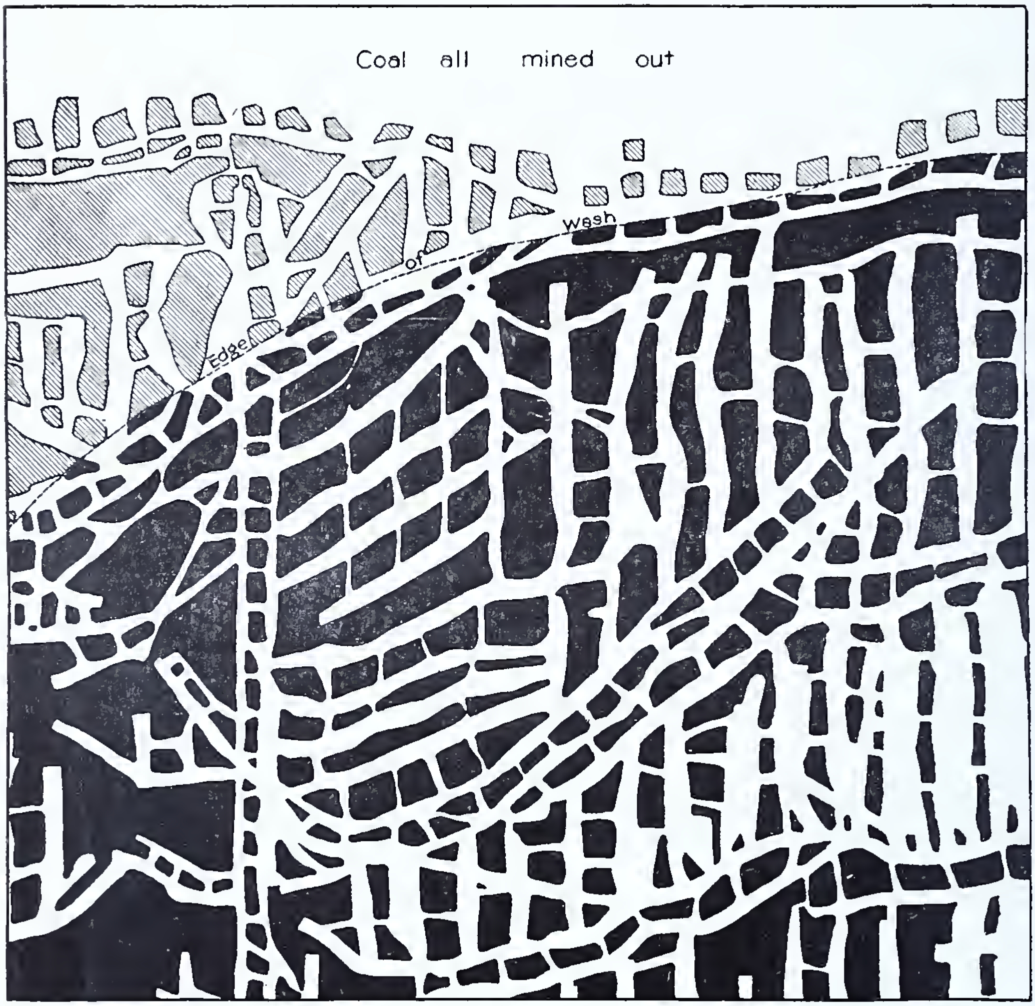


PLAN AND PROFILE OF MINE
Luzerne County Penn.
Showing unminable area due to insufficent rock cover under Buried Valley

▨ Coal that will be extracted in whole or in part

■ Coal lost

Figure 6



SECTION OF MINE MAP
Luzerne Co Penn
Showing edge of water bearing wash

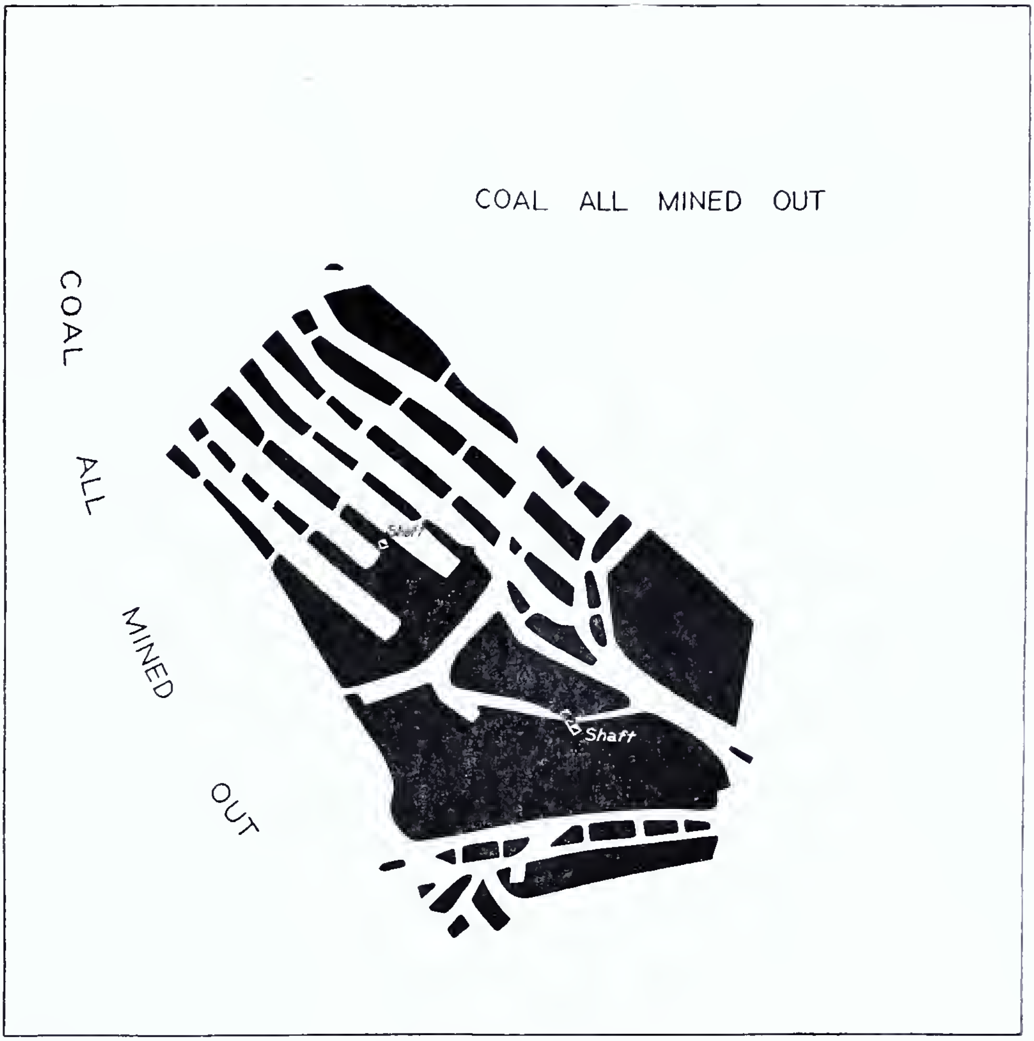
▨ Coal that will be extracted in part or in whole ■ Coal lost

Loss from Mining Practice

The superposition of 12 to 26 anthracite beds, separated a few feet to 200 feet by strata of various kinds of rock, naturally complicates the extraction of coal.

Shaft pillars. In order to reach the coal beds it is necessary to sink shafts from the surface; and as these shafts are the main entries to the mine, they must be protected from any movement of the ground caused by mining. Figure 7 shows a pillar protecting a shaft. Most of this coal cannot be recovered without endangering the shaft, therefore, this coal is considered as unavoidably lost.

Figure 7



SECTION OF MINE MAP
Lackawanna County, Penn.
Showing Reservation for Shaft Pillar Hoisting Shaft, Air Shaft, and Colliery Buildings.

▨ Coal Lost

Barrier pillars. In the anthracite region the coal beds have been mined so extensively that workings from one colliery approach close to those of other collieries. According to the State law, the mine operators must provide what are known as "barrier pillars" to prevent the workings in one colliery from breaking through into another. These pillars act as a protection for the men because a disaster in one mine will not extend through the barrier pillars into an adjoining mine. Generally speaking, the barrier pillars are columnated, and as the depth below the surface increases, the thickness of these barriers likewise increases. In general, the coal that is in barrier pillars can never be recovered, and therefore is lost. Figure 8, a section of a Luzerne County mine, shows a barrier pillar between two adjoining properties.

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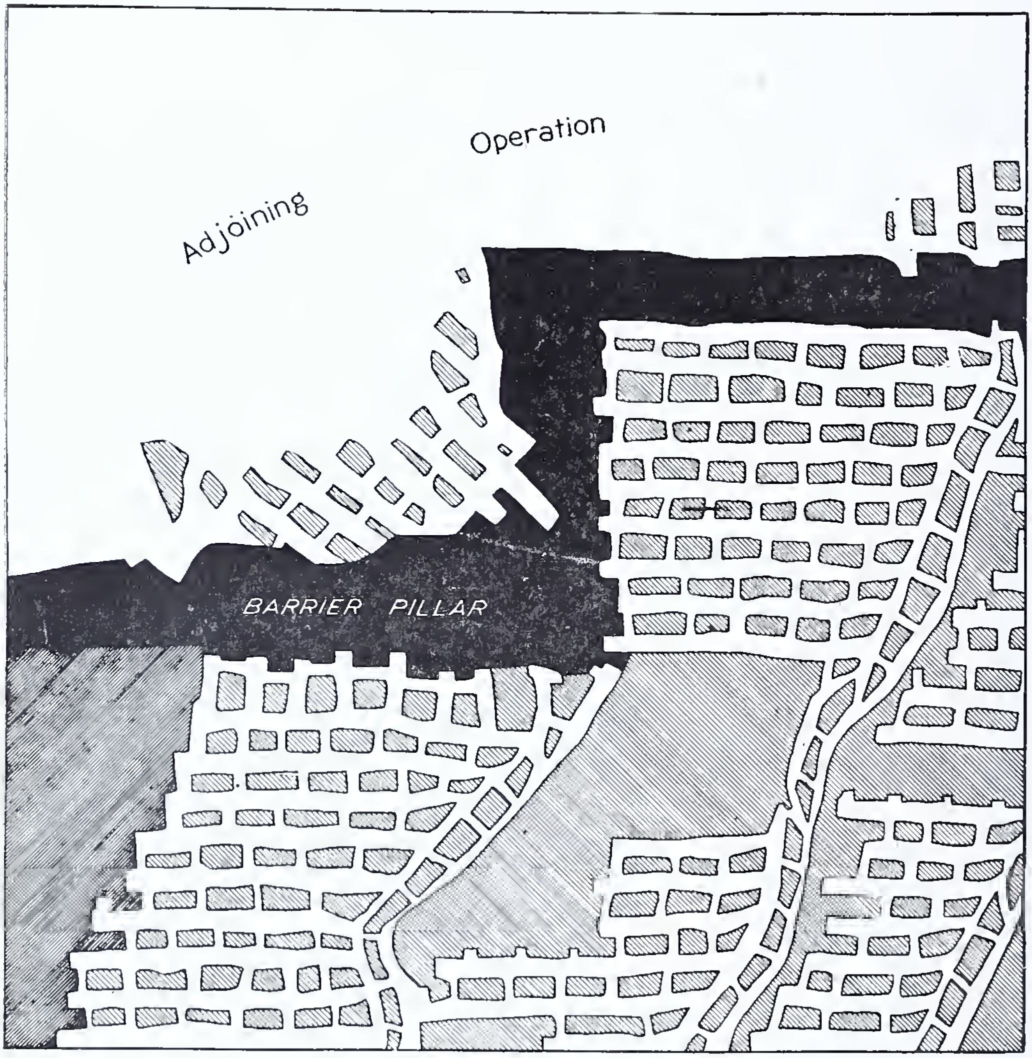
Figure 8



SECTION OF MINE MAP
Luzerne County, Penn.
Showing Barrier Pillar between two Collieries

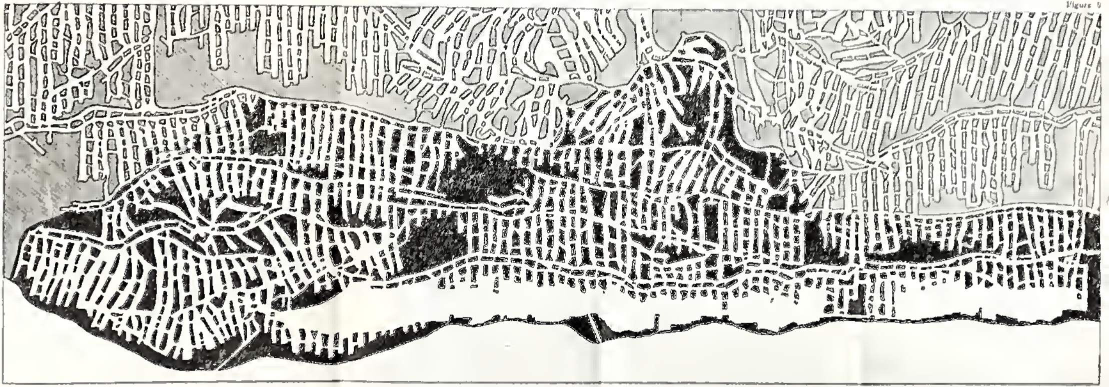
▨ Virgin Coal

▧ Coal that will be extracted in part or in whole.

■ Coal Lost

Mine fires. As a result of carelessness or accident, fires start underground, and unless controlled, they may spread and destroy the whole mine. Figure 9 shows a fire area in a mine in Lackawanna County. This map shows that stoppings have been built completely surrounding the fire area. These stoppings prevent the circulation of air through the workings. When the fire forms enough incombustible gases it may extinguish itself. (See Bureau of Mines Report of Investigation No. 2325, Feb., 1922, entitled "Fighting a mine fire with its own gases," by C. A. Allen and A. C. Watts.) Until a fire is actually extinguished and the passageways are reopened, the coal in the fire area is considered as lost.

Figure 9



SECTION OF MINE MAP

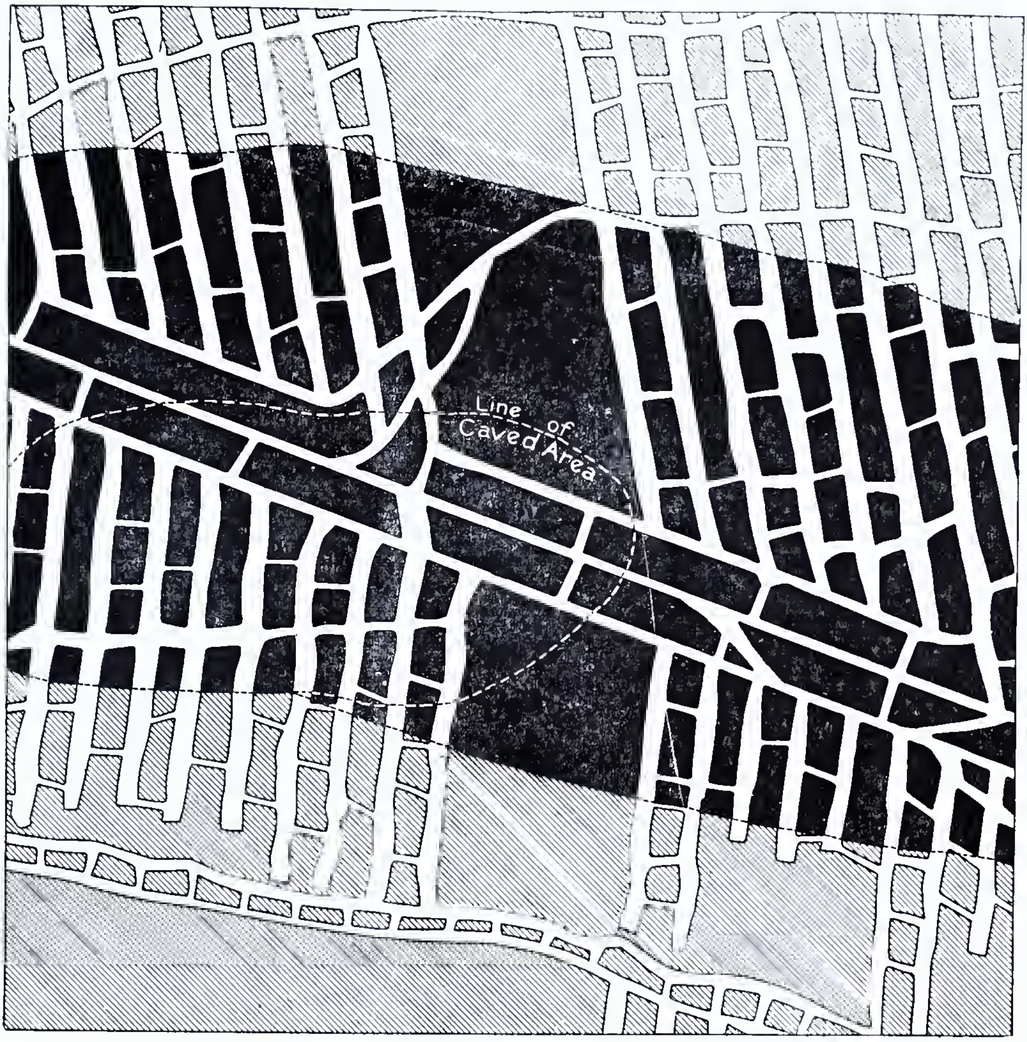
Lackawanna County Penn

Showing Coal Lost due to Mine Fire

▭ Coal mined (first mining) ■ Coal lost whole or in part

Squeezes. The present mining practice in the anthracite region provides the columnating of the room pillars so as to prevent squeezes. It is also customary in modern practice to leave, at stated intervals, reserve pillars to prevent a possible squeeze in one section from spreading to another section . Figure 10 shows an area which has one of these pillars; it also shows that the amount of coal removed is comparatively small; nevertheless a squeeze has occurred, and it is extremely doubtful if the coal in such an area will be recovered. At present this coal is considered as lost.

Figure 10



SECTION OF MINE MAP
Luzerne County, Penn.
Showing Coal Lost in Squeezed Area Coal 7ft. thick.
Depth below surface 1040 ft

▨ Coal that will be extracted in whole or in part ■ Coal Lost

Flooding. After a coal mine has been worked out and abandoned, the old workings are allowed to fill with water. Then, if the adjoining operator accidentally breaks through the barrier pillar, the water in the old mine may flow into the operating mine and flood its lower areas. This means that if the expense of the removal of this water is too great, these workings will be abandoned and the coal remaining therein will be utterly lost. Fortunately, however, there have been only a few such instances in the anthracite region.

If by improper mining, or by accident, the top rock breaks either into the water-bearing measures of the Buried Valley or under a river, the mine may be flooded. As it may be utterly impossible to dewater such an operation, all of the coal may be lost. Two collieries in the anthracite region have been lost from this cause.

Water. Water may or may not cause a loss in the recovery of coal. If it exists in large volume, and is too expensive to handle, then it may render the coal economically of little or no value; but in the anthracite field, very little loss of coal has resulted from this source. Water, however, may inconvenience the miner and decrease the production, but it is more likely to increase the cost of production due to the cost of pumping.

Water pumped from Pennsylvania anthracite mines in 1921.

Field	Northern	Eastern Middle	Western Middle	Southern
Number of pumps	460	111	213	108
Capacity, gallons per minute	336.362	113,116	126.258	80,443
Gallons raised in 1921	116,945,000,000	18,524,000,000	34,327,000,000	26,349,000.000
Tons raised	435,000,000	67,900,000	127.300,000	90,000,000
Distance raised, feet	395	451	516	650
Foot tons	171,825,000,000	30,442,900,000	65,686.800,000	58,500.000,000
Tons of water raised per ton of coal	10.8	11.5	12.7	9.2

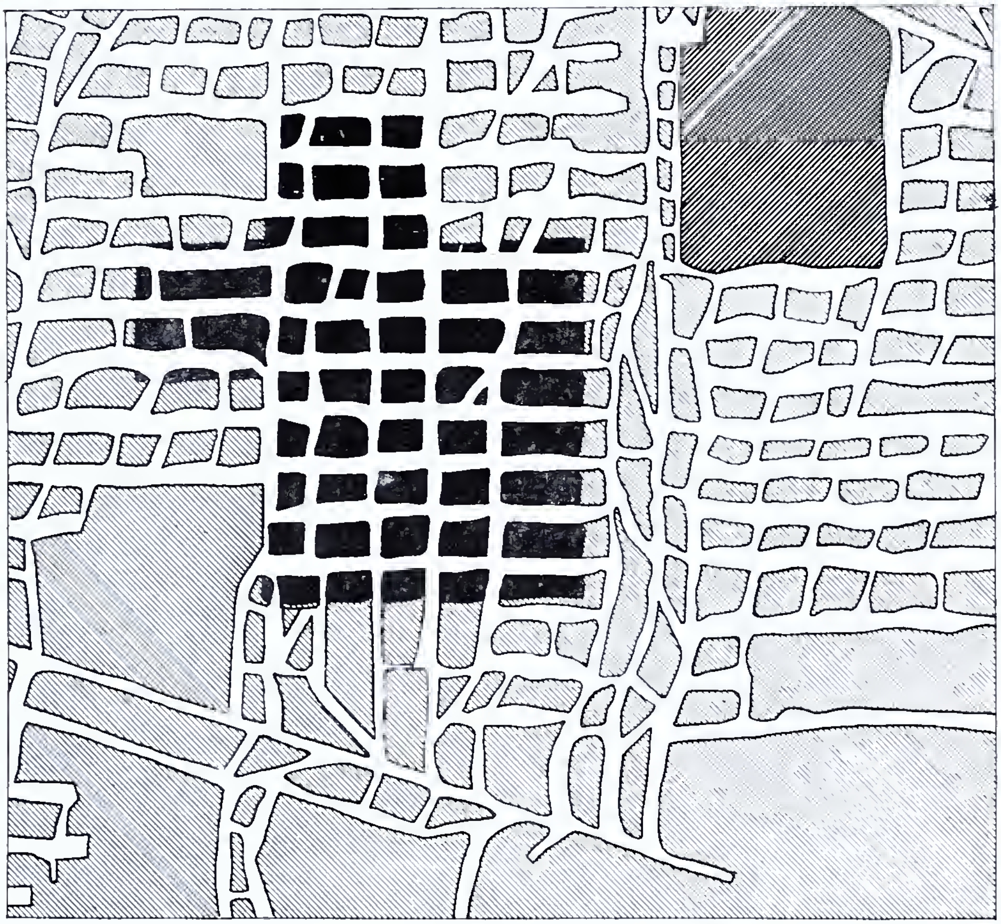
In the Northern Field it is estimated that there are 460 pumps raising water to the surface. These pumps have a capacity of 336,362 gallons per minute, and in 1921 they handled 116,945,000,000 gallons, or 435,000,000 tons. For the entire anthracite region in 1921, an average of 10.9 tons of water was pumped per ton of coal mined.

Built-up or occupied areas. Particularly in the Northern Field, several cities such as Wilkes-Barre, Scranton, Nanticoke, Pittston, and smaller towns such as Olyphant, Kingston, Warrior Run, etc., have been built on areas underlain with coal. Where the companies have no right to "second mine" in such areas, and are required to support the surface, pillars must be left for this purpose, and therefore the coal in such pillars is lost.

Railroads. Where railroads pass over a mining property, pillars must be left to prevent subsidence. Such pillars may or may not be permanently lost, but generally they are. (See Figure 4.)

Lease restrictions. Some of the leases in the anthracite region specifically state that only a certain percentage of the coal may be removed (See Figure 11), and therefore any coal which is left because of the requirements of the lease is considered as lost.

Figure 11

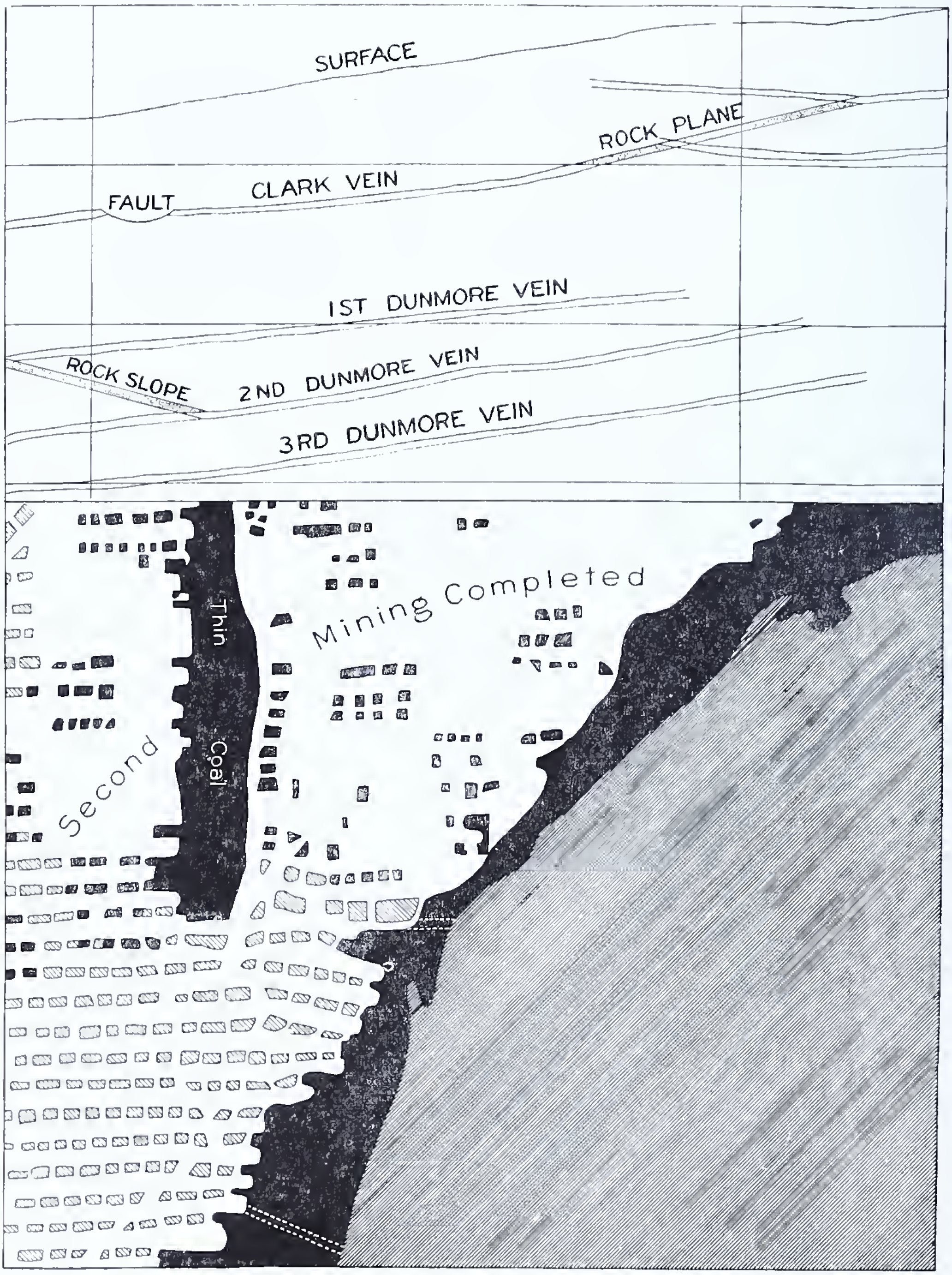


SECTION OF MINE MAP
Luzerne County, Penn.
Showing Lease Restriction. Extraction limited to 60%

▨ Virgin Coal ▧ Coal that will be extracted in part or in whole ■ Coal lost

Second mining. Second mining covers all stages of mining after the first, until all of the recoverable coal has been removed. In the anthracite region it consists mainly of pillar extraction. These pillars are recovered either by taking a skip, slice or slab off the pillar until the end of the old room is reached, and then drawing the pillar back, or by driving a pillar hole through the pillar up to the end of the old chamber, and then drawing the pillar back. In either case the weight of the overlying measures comes on the coal, and the pressure often crushes the rest of the pillar so that it becomes unrecoverable. Examples of these lost pillars can be seen in Figures 3 and 12. Sometimes it is necessary to leave a pillar in order to divert the directon of water, as is shown in Figure 13.

Figure 12



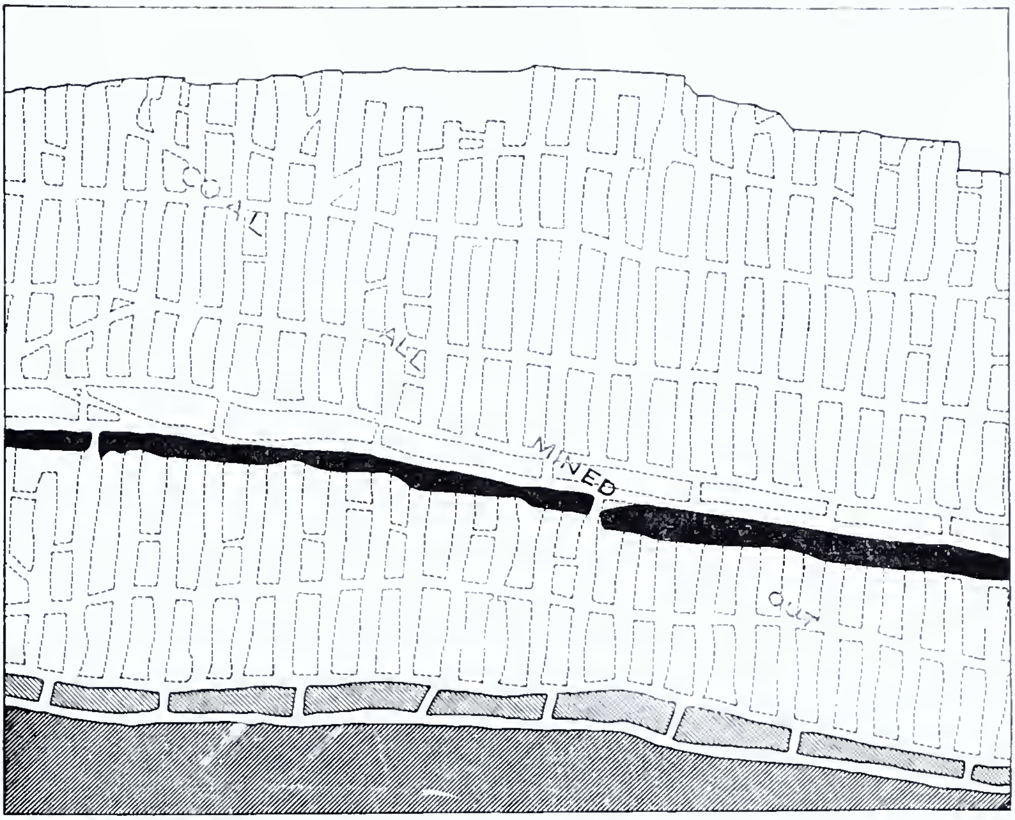
PLAN AND PROFILE OF MINE
Lackawanna County Pa

Losses of coal due to fault, thin coal
and second mining where pillars were lost
Clark Bed

▨ Virgin Coal
☐ Coal that will be extracted in part or in whole
■ Coal Lost

A14
2

Figure 13



SECTION OF MINE MAP
Luzerne Co. Penn.

Showing Pillar lost on account of changing direction of flow of water

▨ Virgin Coal
▧ Coal that will be extracted in part or in whole.
▩ Coal lost

Gob. Where it is necessary to take down top rock or take up bottom rock in a coal mine in order to provide enough height for the movement of men or cars, coal becomes mixed with this rock, and is lost in the gob in the old workings.

Rock partings are frequent in coal beds. As far as possible it is desirable to leave this rock underground and not send it to the surface. Coal often adheres to this parting rock, and is lost. When there is much gob in the working places and the coal is shot down by heavy charges of explosives, some of the coal is blown into the gob and is lost. It has been impossible to determine a figure for the whole anthracite region, but the indications are that in the Northern Field about 0.5 per cent of the daily output is lost in this manner.

Where the rock cannot be gobbed in the mine it is sent to the surface. It is estimated that the coal lost in the rock in the Northern Field amounts to less than 0.5 per cent of the daily output. No gobbing is done where the beds pitch steeply, and therefore in the other fields there is practically no loss from this source. In the Southern Field and parts of the Middle Western Field, where gangways are driven in rock, no coal is mixed with it, and therefore there is no loss.

Transportation. As is to be expected, a considerable quantity of coal is shaken off mine cars, or is spilled by the opening of the car door in transit. Very little of this coal spilled along the track is lost because the anthracite companies clean up their tracks at stated intervals. The coal spilled is loaded into empty mine cars and sent to the breakers for preparation.

A very small quantity of coal is lost by being left behind in the rooms when the men load their cars, but this loss is practically negligible.

In stripping operations, after the coal has been removed, it is customary to use drag-scrapers to gather the coal left behind the steam-shovel. This coal is later loaded into cars and sent to the breakers; here too the loss from coal left behind is exceedingly small.

Loss in Preparation

In the preparation of anthracite, loss occurs in a number of ways. There is the actual loss of coal that becomes mingled with the breaker refuse; there is also the loss from the extremely fine sizes passing away in the wash water; and the loss from coal breaking down in handling. This is not a real physical loss of the coal, but a profitable size of coal is reduced to an unprofitable one, resulting in a financial loss. Another financial loss occurs in the preparation of sizes of coal too small to be of economic value at the present time. In many places these small sizes are stored in slush banks for probable future consumption. At other collieries they are mingled with the breaker refuse, and therefore become absolutely lost; while at still other places, where slushing is employed, the fine sizes are sent back to the mine mingled with the crushed breaker refuse and are lost.

The loss due to degradation occurs in the fines resulting from the production of marketable sizes of coal; in passing the coal through the jigs and various mechanical cleaning devices; in sending the coal through long iron shoots from one elevation to a lower one in the breaker; and in the final passage of the coal into the pocket and from the pocket to the railroad car.

Avoidable and Unavoidable Losses

The losses of anthracite in mining may be divided into two classes, avoidable and unavoidable. (1) Avoidable losses or partly avoidable losses might be classified as (a) those under built-up or occupied areas where the coal might be recovered by adopting some other system of mining; (b) losses due to carelessness such as mine fires, and by squeezes caused by poor engineering; (c) flooding of mines from old workings where proper precautions have not been taken; (d) the loss of coal in gob and mine rock, which, with possible closer supervision might be reduced; and (e) losses in preparation due to degradation, which could probably be reduced. A change in the sizes of prepared coal might also reduce losses. (2) Unavoidable losses would cover coal left in (a) barrier pillars; (b) shaft pillars; (c) under rivers; (d) under railroads; (e) under Buried Valley; (f) to squeezes and (g) to accidental flooding of mines.

DISCUSSION OF LOSSES BY FIELDS.

The preceding part of this report has described in detail the various losses which do and may take place in the first and second mining of anthracite. These will now be considered by fields.

Northern Field

Ten beds of coal have been developed in the Northern Field, and seven of these occur in two or more splits, making a total of 22 beds and splits. The percentage of recovery by first and second mining has been calculated from data furnished by 48 collieries producing approximately 23,665,829 gross tons.* It will be noted when comparing this figure with the total tonnage shown in Table 1, that the two do not agree. The reason for this is that the information from one or two collieries was not complete, and the data could not be used. The 48 collieries reported a total area underlain with coal, considering the bed in each colliery with the greatest area, of 51,045 acres, or a total superficial** area underlain therewith of 249,011 acres. In other words, there are 249,011 acres of coal beds in the 48 collieries. From these figures it is possible to estimate that the total superficial area of all beds in the Northern Field amounts to 549,693 acres, and the developed area as reported shows 130,802 acres, or an estimate for the whole field of 289,000 acres. This shows that 52.6 per cent of the area has been developed. It has been possible to make an estimate on the original tonnage in the ground as shown in Table 2, which gives 5,447,623,000 tons. This compares closely with the estimate made by the Second Pennsylvania Geological Survey—namely 5,697,381,000 tons.

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*Gross tons of 2,240 pounds used throughout this report.

**The term "superficial area" as used in this report means the area of the bed as measured on the horizontal. "Total superficial area" means total area, thus measured, of all beds. In calculating tonnage the pitch of the coal bed was taken into consideration.

TABLE 1.—*Estimated area underlain with coal, developed area, thickness and recovery by beds in the Northern Field.*

Name of bed		Superficial area underlain with coal, acres reported by companies	Estimated total superficial area underlain with coal, acres	Per cent of lowest bed	Area developed, acres	Per cent of superficial area underlain with coal reported by companies	Tonnage produced, gross tons	Per cent of total	Per cent of region total	Average thickness of beds					
										Total		Partings		Coal	
										Ft.	In.	Ft.	In.	Ft.	In.
K.	Snake Island	316	698	0.6	127	40.2	113,003	0.5	0.2	8	5	3	4	5	1
J.	Abbott	6,445	14,227	12.6	2,469	38.3	525,973	2.3	1.1	6	9	1	0	5	9
I.	Top George	9,073	20,029	17.8	2,911	32.1	853,795	3.8	1.9	6	7	1	0	5	7
	Kidney	3,951	8,722	7.7	1,806	45.7	180,908	0.8	0.4	7	6	1	8	5	10
H.	Hillman Orchard	13,850	30,573	27.1	6,812	49.2	1,076,233	4.7	2.3	7	4	0	10	6	6
G.	Top Split	3,832	8,459	7.5	1,821	47.5	375,976	1.7	0.8	6	2	1	7	4	7
	Bottom Split	14,101	31,128	27.6	6,760	47.9	1,356,147	6.0	3.0	6	0	1	3	4	9
F.	Top Split	2,608	5,757	5.1	1,439	55.2	476,776	2.1	1.0	5	10	1	4	4	6
	Bottom Split	15,246	33,656	29.9	7,798	51.1	1,211,924	5.3	2.6	5	5	0	8	4	11
E.	Top Split	4,858	10,724	9.5	2,326	47.9	49,156	0.2	0.1	4	11	0	6	4	5
	Middle Split	16,656	36,768	32.6	9,565	57.4	1,019,063	4.5	2.2	7	10	0	8	7	2
	Bottom Split	14,473	31,949	28.4	6,843	47.3	1,020,625	4.5	2.2	7	0	1	7	5	5
	No Split	9,834	21,709	19.3	8,646	87.9	888,354	3.9	1.9	11	0	1	4	9	8
D.	Top Split	1,047	2,311	2.1	657	62.8	152,978	0.7	0.3	3	2	0	8	2	6
	Bottom Split	2,582	5,700	5.1	1,822	70.6	260,555	1.1	0.6	5	10	1	9	4	1
	No Split	14,551	32,121	28.5	7,190	49.4	1,967,517	8.7	4.3	5	10	1	5	4	5

C	Top Split	10,176	22,464	19.9	5,407	53.1	755,956	3.3	1.6	5	3	1	2	4	1
	Middle Split	2,130	4,702	4.2	1,602	75.2	123,363	0.5	0.3	4	8	0	10	3	10
	Bottom Split	18,278	40,349	35.8	8,350	45 7	1,514,907	6.7	3.3	6	0	1	2	4	10
	No Split	13,620	30,066	26.7	10,315	76.0	1,915,852	8.4	4.2	7	8	1	8	6	0
B	Top Top Split	20,868	46,066	40.9	6,668	32.0	1,334,294	5 9	2.9	5	0	0	10	4	2
	Bottom Top Split	1,604	3,541	3.1	1,138	70.9	44,794	0.2	0.1	4	2	0	10	3	4
	Middle Split	11,492	25,369	22.5	7,716	67.1	1,514,955	6.7	3.3	4	2	1	0	3	2
	Bottom Split	29,474	65,064	57.7	16,373	55.6	3,127,136	13.8	6.8	7	3	1	4	5	11
	No. 4 Dunmore	4,223	9,322	8.3	1,781	42.2	232,875	1.0	0.5	4	9	0	6	4	3
	No Split	3,723	8,219	7.3	2,430	65.3	623,962	2.7	1.4	13	2	2	9	10	5
	Total	249,011	549,693		130,802	52.6	22,717,077	100.							
	Total for region						45,911,900								
	Estimated area lowest bed	51,045	112,640												

TABLE 1.—*Estimated area underlain with coal, developed area, thickness and recovery by beds in the Northern Field*—Continued.

Name of bed	Per cent recovery first mining			Per cent recovery second mining			Total per cent recovery		
	Minimum	Maximum	Weighted average	Minimum	Maximum	Weighted average	Minimum	Maximum	Weighted average
K. Snake Island	35.3	55.0	43.2	4.5	31.9	14.6	39.8	76.9	57.8
J. Abbott	37.5	75.0	54.6	9.0	46.	15.0	52.0	88.5	69.6
I. Top George	45.0	64.7	52.8	10.0	29.2	19.0	66.5	88.0	71.8
I. Kidney	39.6	70.0	52.0	7.8	25.8	15.3	51.9	78.8	67.3
H. Hillman Orchard	19.2	72.0	50.6	1.2	25.2	20.5	27.0	78.3	71.1
G. Top Split	40.0	65.0	55.4	5.6	33.7	10.8	63.4	88.7	66.2
G. Bottom Split	37.1	66.3	54.3	14.4	33.9	24.0	45.0	89.6	78.3
F. Top Split	34.4	62.7	47.8	13.1	35.0	21.0	34.4	73.7	68.8
F. Bottom Split	38.6	68.0	55.0	10.3	34.9	16.8	49.8	79.9	71.8
E. Top Split	26.5	63.4	44.4	8.3	31.0	18.4	26.5	8.3	62.8
E. Middle Split	36.9	65.6	49.0	5.6	24.5	16.9	46.8	81.5	65.9
E. Bottom Split	29.7	64.3	45.7	8.6	24.3	12.8	46.2	80.0	58.5
E. No Split	19.8	90.0	42.7	19.8	31.8	16.1	19.8	90.0	58.8
D. Top Split	45.0	60.0	50.1	28.0	28.0	0.0	45.0	88.0	50.1
D. Bottom Split	49.3	62.0	51.4	25.8	30.3	2.9	49.3	84.4	54.3
D. No Split	38.2	90.0	53.3	3.8	32.0	14.9	55.0	90.0	68.2

C.	Top Split	34.3	67.9	53.0	5.5	31.5	18.2	45.6	88.0	71.2
	Middle Split	45.7	45.7	45.7	16.0	16.0	16.0	61.7	61.7	61.7
	Bottom Split	33.9	64.7	47.9	16.0	36.9	26.9	53.9	88.7	74.8
	No Split	38.8	90.0	56.4	0.6	34.0	19.4	50.5	92.0	75.8
B.	Top Top Split	29.4	60.0	50.6	15.4	33.5	23.9	32.8	87.0	74.5
	Bottom Top Split	55.0	90.0	56.4	14.6	30.0	28.8	73.1	90.0	85.2
	Middle Split	42.6	90.0	53.4	2.0	31.5	25.8	42.6	93.9	79.2
	Bottom Split	29.7	89.1	46.5	6.9	38.4	28.0	45.5	89.1	74.3
	No. 4 Dunmore	47.0	63.0	45.2	9.0	28.9	23.1	68.1	76.1	68.3
	No Split	40.8	58.8	42.9	11.1	17.6	12.8	55.3	58.8	55.7
	Total			49.5			21.2			70.7

In Table 1 the figures in column entitled Superficial area underlain with coal, are the sum of the areas for each bed reported by the coal companies. The next column was calculated from information secured from maps of the Second Geological Survey of Pennsylvania, and applying the ratios of the bed area of the lowest bed as reported by the coal companies to the total area of that bed.

TABLE 2.—*Original and remaining reserves of coal and present recovery in Northern Field, by beds in gross tons*

	Name of bed		Estimated original tonnage	Per cent re-covery	Average estimated amount of coal removed per year, tons	Estimated total amount of coal removed to date, tons	Estimated amount of coal remaining, tons
K.	Snake Island		6,513,000	57.8	137,000	1,370,000	5,143,000
J.	Abbott		153,776,000	69.6	533,000	53,300,000	100,576,000
I.	Kidney or Bowkley or		205,481,000	71.8	837,000	83,700,000	121,781,000
	George		93,476,000	67.3	189,500	18,950,000	74,526,000
H.	Hillman or Orchard		364,075,000	71.1	1,062,000	106,200,000	257,875,000
G.	Stanton or Mills or		71,285,000	66.2	400,000	40,000,000	31,285,000
	Diamond		270,876,000	78.3	1,368,000	136,800,000	134,076,000
F.	Checker or		47,462,000	68.8	487,000	24,350,000	23,112,000
	Rock		302,122,000	71.8	1,325,000	92,700,000	209,422,000
E.	Baltimore		86,445,000	62.8	55,100	3,310,000	83,135,000
			484,985,000	65.9	1,085,000	108,500,000	376,485,000
			316,075,000	58.5	1,227,000	122,700,000	193,375,000
		(a)	384,584,000	58.8	1,062,000	106,200,000	278,384,000
D.	Marcy		10,585,000	50.1	215,000	8,600,000	1,985,000
	or New County		42,814,000	54.3	337,000	33,700,000	9,114,000
		(a)	258,920,000	68.2	2,270,000	158,900,000	100,020,000
C.	Clark		168,731,000	71.2	746,000	52,200,000	116,531,000
	or		33,165,000	61.7	140,000	8,420,000	24,745,000
	Ross		358,510,000	74.8	1,585,000	158,500,000	200,010,000
		(a)	330,485,000	75.8	1,975,000	197,500,000	132,985,000
			354,450,000	74.5	1,400,000	140,000,000	214,450,000
B.	Red Ash		21,828,000	85.2	36,900	2,210,000	19,618,000
			148,724,000	79.2	1,495,000	89,800,000	58,924,000
	or Dunmores	(a)	703,078,000	74.3	3,300,000	330,000,000	373,078,000
			72,582,000	68.3	239,000	14,350,000	58,232,000
			156,596,000	55.7	786,000	78,600,000	77,996,000
	Total		5,447,613,000	70.7	24,292,500	2,170,860,000	3,276,763,000
	Pennsylvania Second Geological Survey		5,697,381,000				

Note—under each letter the different splits of the beds are shown. Where no splits were reported the figures are indicated by the letter "a".

In Table 2 the column entitled Estimated original tonnage is the total procured by multiplying the bed area by the weighted average thickness times the tons of coal per foot acre and allowing for pitch of beds.

By weighting the recovery of first and second mining by thickness of bed, superficial area, and tonnage produced, it has been possible to calculate for each bed the estimated weighted average recovery, and also this recovery for the whole Northern Field. The recovery as shown by Table 1 for the first mining in this field is 49.5 per cent, with a minimum of 19.2 per cent, and a maximum of 90 per cent.

For second mining the estimated weighted average recovery is 21.2 per cent, and a minimum of 0.6 to 46.3 per cent as a maximum. The total recovery in this field, therefore, is 70.7 per cent, the minimum being 19.8 per cent, and the maximum, 93.9 per cent.

It is interesting to study the last column in Table 1, which shows the estimated average total recovery by beds. It will be noted that the percentage generally decreases as the depth of the beds increases until a point is reached between the "E" and the "D" beds, when the recovery again increases sharply, and then as the beds again become deeper it decreases once more. This is due to the position of the beds in the Northern Field. As previously stated, in the Nanticoke district or the western end of that field, the beds lie very deep. In the Wilkes-Barre district, which is in the central part of the field, the depth is not quite as great; while in the Lackawanna district, the depth is much less, and the great production of this district comes from the lower beds, geologically speaking. As these beds are near the surface the percentage of recovery is extremely high, and as the total tonnage recovered and the superficial area of these beds is rather great, they have a considerable influence on the estimated weighted total average recovery and increase it to a high point.

(See Bibliography 1, 2. and 3.)

From the information at hand it was possible to estimate the amount of coal removed each year from the beds, and from this to estimate the total coal removed. The difference between these figures and the estimated original tonnage gives the estimated quantity of recoverable coal. Table 2 shows that in the Northern Field 2,170,860,000 tons of coal has been removed from the ground, leaving 3,276,763,000 tons in the ground. Assuming the actual recovery in the Northern Field in 1921 to be 45,911,000 tons of coal, and applying the percentage of recovery of the field, it is estimated that the life of the Northern Field will be approximately 48 years.

Eastern Middle Field

As previously stated, the Eastern Middle Field is the smallest of the four in the anthracite region. In Table 3 it is estimated that the area of the beds in the collieries amounts to about 20,120 acres, and the area reported by the various collieries selected shows an area of 10,829 acres. The superficial area underlain with coal of all beds from the reporting collieries shows 24,909 acres, and it is estimated that the total superficial area underlain with coal amounts to 48,649 acres. Of the 24,909 acres, 19,705 acres are developed, or development of 79.1 per cent.

TABLE 3.—*Estimated area underlain with coal, developed area, thickness and recovery by beds in the Eastern Middle Field.*

Name of bed	Superficial area underlain with coal, acres reported by companies	Estimated total superficial area underlain with coal, acres	Per cent of lowest bed	Area developed, acres	Per cent of superficial area underlain with coal reported by companies	Tonnage produced, gross tons	Per cent of total	Per cent of region total	Average thickness of beds: Total Ft.	Total In.	Partings Ft.	Partings In.	Coal Ft.	Coal In.
L. Little Tracy	43	84	0.4	35	81.4	30,140	0.8	0.4	4	8	1	9	2	11
K. Big Tracy	133	260	1.2	91	68.4				4	4	0	6	3	10
J. Upper Diamond	323	631	3.0	232	71.8	16,570	0.5	0.2	8	4	1	11	6	5
No. 2	233	455	2.2	219	94.0	0			4	2	1	2	3	0
No. 1	63	123	0.6	41	65.1	0			3	4	0	0	3	4
Lower Diamond	256	500	2.4	229	89.5	0			8	11	3	5	5	6
I. Little Orchard	103	201	1.0	86	83.5	60,232	1.6	0.9	5	2	1	6	3	8
H. Orchard	334	652	3.1	276	82.6				4	10	1	7	3	3
G. Primrose	759	1,482	7.0	545	71.8	19,635	0.5	0.3	7	4	0	5	6	11
F. Holmes														
E. Mammoth	2,977	5,814	27.5	2,815	94.6	1,083,112	29.5	15.6	21	11	2	8	19	3
D. Wharton	3,994	7,800	36.9	3,382	84.7	519,996	14.2	7.5	8	7	2	2	6	5
C. Gamma	4,700	9,180	43.4	3,001	63.9	603,994	16.5	8.7	4	10	1	0	3	10
B. Buck Mt. Little Buck Mt.	9,111	17,795	84.1	7,262	79.7	1,179,659	32.1	17.0	6	7	1	2	5	5
A. Lykens Valley	1,880	3,672	17.4	1,491	79.3	157,301	4.3	2.3	4	4	1	2	3	2

Total	24,909	48,649		19,705	79.1	3,670,639	100.0	52.7			
Regional total						6,958,000					
Estimated area, lowest bed	10,829	20,120									

Name of bed	Per cent recovery first mining			Per cent recovery second mining			Total per cent recovery		
	Minimum	Maximum	Weighted average	Minimum	Maximum	Weighted average	Minimum	Maximum	Weighted average
L. Little Tracy	45.0	45.0	45.0	40.0	40.0	40.0	85.0	85.0	85.0
K. Big Tracy	45.0	45.0	45.0	22.3	22.3	22.3	67.3	67.3	67.3
J. Upper Diamond	50.0	50.0	50.0	22.6	22.6	22.6	72.6	72.6	72.6
J. No. 2	50.0	50.0	50.0	14.5	14.5	14.5	64.5	64.5	64.5
J. No. 1	50.0	50.0	50.0	16.3	16.3	16.3	66.3	66.3	66.3
J. Lower Diamond	50.0	50.0	50.0	20.9	20.9	20.9	70.9	70.9	70.9
I. Little Orchard	50.0	50.0	50.0	23.1	23.1	23.1	73.1	73.1	73.1
H. Orchard	50.0	50.0	50.0	15.8	15.8	15.8	65.8	65.8	65.8
G. Primrose	50.0	90.0	50.2	20.4	25.0	20.3	70.4	90.0	70.5
F. Holmes									

3mm

TABLE 3.—*Estimated area underlain with coal developed area, thickness and recovery by beds in the Eastern Middle Field*—Continued

Name of bed	Per cent recovery first mining			Per cent recovery second mining			Total per cent recovery		
	Minimum	Maximum	Weighted average	Minimum	Maximum	Weighted average	Minimum	Maximum	Weighted average
E. Mammoth	39.3	90.0	52.6	12.7	33.8	20.0	50.9	88.7	72.6
D. Wharton	44.1	64.0	48.3	19.4	29.4	26.3	69.4	88.4	74.6
C. Gamma	44.3	64.0	50.8	20.3	33.5	26.5	70.3	84.1	77.3
B. Buck Mt. Little Buck Mt.	43.7	64.0	54.2	16.2	33.9	21.4	66.2	88.7	75.6
A. Lykens Valley	39.6	55.0	53.9	25.5	34.9	27.1	74.5	85.0	81.0
Total			49.0			24.7			73.7

In 1921 there was produced in this region approximately 6,958,000 tons, and the reporting collieries (11 of the 27 in the field) show an output of 3,670,639 tons, or 52.7 per cent of the total. As in the Northern Field, the gross tonnage produced will vary in each of the tables.

Knowing the pitch of the coal, average thickness of beds, and superficial or horizontal area underlain with coal, it has been possible to make an estimate by beds of the original contents. This worked out to a total of 612,448,000 tons, as compared with an estimate made by the Pennsylvania Second Geological Survey[6], amounting to 602,491,000 tons, as shown in Table 4.

Table 3 shows the estimated weighted average recovery by beds for first mining. This recovery amounts to 49 per cent, and the minimum shown is 39.3 per cent and a maximum of 90 per cent. The recovery by second mining amounts to 24.7 per cent, with a minimum of 12.7 per cent and a maximum of 40 per cent. The total estimated weighted average recovery for the Eastern Middle Field is 73.7 per cent, with a minimum of 50.9 per cent and a maximum of 90 percent.

As was done in the Northern Field, an estimate was made of the remaining reserves of coal in the Eastern Middle Field, as shown in Table 4. The total amount of coal removed to date is indicated to be about 267,535,000, leaving approximately 344,930,000 tons to be recovered in the future. At the present rate of production, taking into consideration the per cent mined out, the life of this field will be about 37 years.

TABLE 4.—*Original and remaining reserves of coal and present recovery in the Eastern Middle Field, by beds in gross tons.*

Name of bed	Estimated original tonnage	Per cent recovery	Average estimated amount of coal removed per year, tons	Estimated total amount of coal removed to date, tons	Estimated amount of coal remaining, tons
L. Little Tracy	445,000	85.0			
K. Big Tracy	1,833,000	67.3	31,000	1,860,000	418,000
J. Diamond	7,397,000	72.6	30,000	2,400,000	4,997,000
	2,500,000	64.5	20,000	1,200,000	1,300,000
	751 000	66.3	5,000	350,000	401,000
	5,038,000	70.9	25,000	2,000,000	3,038,000
I. Little Orchard	1,352,000	73.1	63,000	4,410,000	824,000
H. Orchard	3,882,000	65.8			
G. Primrose	28,960,000	70.5	65,000	6,500,000	22,460,000
F. Holmes					
E. Mammoth	205,037,000	72.6	1,090,000	109,000,000	96,037,000
D. Wharton	91,453,000	74.6	509,000	50,900,000	40,553,000

TABLE 4.—*Original and remaining reserves of coal and present recovery in the Eastern Middle Field, by beds in gross tons*—Continued

Name of bed	Estimated original tonnage	Per cent re-covery	Average estimated amount of coal removed per year, tons	Estimated total amount of coal removed to date, tons	Estimated amount of coal remaining, tons
C. Gamma	64,748,000	77.3	570,000	57,000,000	7,748,000
B. Buck Mountain	177,526,000	75.6	1,140,000	114,000,000	63,526,000
A. Lykens	21,526,000	81.0	142,000	14,200,000	7,326,000
Total	612,448,000	73.7	3,690,000	3 3,820,000	2 8,628,000
Pennsylvania Second Geological Survey	602,491,000				

As the beds of coal in the Eastern Middle Field do not lie flat, but are on a pitch, it would not be expected that the lowest bed geologically would show the lowest rate of recovery, and this is well brought out in the last column in Table 3.

Recovery in the Eastern Middle Field is probably higher than in any of the other fields, owing to the fact that the beds are rather near the surface. In many places it is possible to remove the surface and mine the coal by stripping, which gives in those areas a recovery running well over 90 per cent.

Western Middle Field

The Western Middle Field has a total area, according to the Second Geological Survey[6], of 94+ square miles. The estimated total area of the bed having the greatest superficial area, as reported by the 16 collieries, out of the 51 in the field, and used for these calculations, amounts to 16,769 acres, against a total for the region of 60,160. The total superficial area of all coal beds in these collieries amounts to 81,408 acres, against an estimated total for the region of 292,370. This indicates that approximately 56.2 per cent of the beds have been developed, that is, either first mined or first and second mined.

In 1921, this field produced 16,695,071 tons, and the 16 collieries reported a production of 4,542,375 tons, or 27.1 per cent. Taking these factors, as mentioned above, and knowing the pitch of the coal at the collieries, it is estimated that the original coal in the beds amounted to 4,596,795,000 tons, compared with the estimate of the Second Geological Survey,[6] of 4,609,565,000 tons. This is shown in Table 6.

In Table 5, the estimated weighted average recovery by first mining for the Western Middle Field is shown as 37.7 per cent, with a minimum of 20.8 per cent, and a maximum of 50.0 per cent. The estimated percentage of recovery by second mining is 26.3 per cent, with a minimum of 12.8 per cent, and a maximum of 44.1 per cent, and the total estimated weighted average recovery for the whole field is 64.0 per cent, with a minimum of 37.9 per cent, and a maximum of 93.0 per cent.

The last column of Table 5 shows that there is comparatively little difference in the total percentage of recovery in the various beds. The lowest percentages apply almost entirely to the thickest beds, which is naturally to be expected.

As in the Northern and Eastern Middle fields, an estimate was made of the total amount of coal removed to date, and it is shown in Table 6 that so far this amounts to 1,023,770,000 tons, also, that there probably remains in the ground 3,573,025,000 tons, which with the production remaining at the same rate as in 1921 and the percentage recovery the same would show the average life of the field to be about 124 years. From this it is indicated that a large part of the future production of anthracite will come from this field.

TABLE 5.—*Estimated area underlain with coal, developed area, thickness and recovery by beds, in the Western Middle Field.*

Name of bed		Superficial area underlain with coal, acres	Estimated total superficial area underlain with coal, acres	Per cent of lowest bed	Area developed, acres	Per cent of superficial area	Coal produced in 1921, gross tons	Per cent of total	Per cent of region total	Average thickness of beds					
										Total		Partings		Coal	
										Ft.	In.	Ft.	In.	Ft.	In.
K.	No. 14 Tracy	436	1,600	2.6	108	24.8	7,621	0.2	0.00	7	1	1	3	5	10
J.	No. 13 Diamond	3,718	13,400	22.6	747	20.1	79,149	1.7	0.5	6	8	1	8	5	0
H.	No. 12 Orchard	1,843	6,600	11.0	521	28.3	192,752	4.2	1.2	7	4	1	8	5	8
G.	No. 11½ Primrose	5,933	21,300	35.4	1,706	28.8	135.822	3.1	0.8	7	8	1	4	6	4
	No. 11 Primrose	2,515	9,000	15.0	1,265	50.4	51,200	1.1	0.3	4	5	0	3	4	2
F.	No. 10½ Holmes	626	2,200	3.7	37	5.9				5	6	0	9	4	9
	No. 10 Holmes	9,012	32,400	53.8	4,982	55.3	254,534	5.6	1.5	7	4	1	3	6	1
E½		958	3,400	5.7	860	89.8	54,076	1.2	0.3	3	3	0	2	3	1
E.	No. 9½ Mammoth	2,363	8,500	14.1	233	9.8	69,331	1.5	0.4	5	3	1	0	4	3
	No. 9 Mammoth	7,376	26,500	44.0	5,532	74.9	450,009	9.9	2.7	9	6	1	0	8	6
	No. 8 Mammoth	8,269	29,700	49.3	4,811	58.2	522,352	11.6	3.1	9	2	0	11	8	3
	No. 7½ Mammoth	7,444	26,700	44.4	5,998	80.6	950,105	20.9	5.7	14	10	1	9	13	1
D.	No. 7 Skidmore	4,557	16,400	27.2	3,530	77.0	213,121	4.7	1.3	6	7	0	10	5	9
C.	No. 6 Seven Ft.	4,852	17,400	28.9	1,989	41.0	211,008	4.6	1.3	4	6	0	7	3	11
B.	No. 5 Buck Mt.	9,886	35,500	58.0	6,242	63.3	760,749	16.7	4.6	8	7	1	7	7	0
	No. 4a Buck Mt.	459	1,650	2.7	455	99.2	61,433	1.4	0.4	8	4	0	7	7	9
	No 4 Buck Mt.	8,366	30,100	49.9	5,337	64.3	227,412	5.0	1.4	6	8	1	9	4	11

A.	No. 3 Lykens Valley	283	1,020	1.7	112	39.6	40,685	0.9	0.2	3	3	0	2	3	1
	No. 2 Lykens Valley	1,835	6,600	11.0	1,054	57.4	229,416	5.0	1.4	5	2	0	5	4	9
	No. 1 Lykens Valley	677	2,400	4.0	207	30.6	31,600	0.7	0.2	4	0	0	0	4	0
	Total	81,408	292,370		45,726		4,542,375	100.0	27.3						
	Total for region						16,695,071								
	Estimated area, lowest bed	16,769	60,160												

Name of bed		Per cent recovery first mining			Per cent recovery second mining			Total per cent recovery		
		Minimum	Maximum	Weighted average	Minimum	Maximum	Weighted average	Minimum	Maximum	Weighted average
K.	No. 14 Tracy	39.5	40.0	40.0	19.0	32.0	19.0	59.0	71.5	59.0
J.	No. 13 Diamond	32.3	39.5	36.9	27.5	32.0	29.8	52.3	71.5	66.7
H.	No. 12 Orchard	31.5	50.0	36.5	16.0	32.0	29.1	59.0	71.5	65.6
G.	No. 11½ Primrose	31.9	39.5	35.6	21.3	34.6	29.6	58.7	71.5	65.2
	No. 11 Primrose	37.5	39.5	37.5	30.0	32.0	30.0	67.5	71.5	67.5
F.	No. 10½ Holmes	39.7	44.4	44.4	26.4	29.6	29.6	66.1	74.0	73.0
	No. 10 Holmes	20.8	47.6	37.7	17.1	31.5	22.7	37.9	70.4	60.4
E½		32.8	45.8	36.3	17.1	37.4	25.0	39.0	84.2	61.3
E.	No. 9½ Mammoth	35.2	39.7	39.7	23.5	26.4	26.4	58.7	66.1	66.1
	No. 9 Mammoth	25.1	48.0	40.8	18.9	30.8	27.3	47.5	84.8	68.1
	No. 8 Mammoth	33.6	48.0	39.6	21.9	40.0	28.2	48.0	82.3	67.8
	No. 7½ Mammoth	26.7	45.3	36.1	21.9	30.1	25.4	48.7	79.2	61.5

TABLE 5.—*Estimated area underlain with coal, developed area, thickness and recovery by beds, in the Western Middle Field*—Continued

Name of bed	Per cent recovery first mining			Per cent recovery second mining			Total per cent recovery		
	Minimum	Maximum	Weighted average	Minimum	Maximum	Weighted average	Minimum	Maximum	Weighted average
D. No. 7 Skidmore	27.1	48.0	40.4	14.7	40.1	28.6	49.3	83.1	69.0
C. No. 6 Seven Ft.	27.6	48.0	41.5	22.2	29.5	26.2	50.0	76.7	67.5
No. 5 Buck Mt.	27.2	48.0	36.7	16.9	46.4	27.4	45.1	84.8	64.1
B. No. 4a Buck Mt.	32.9	32.9	32.9	15.4	15.4	15.4	48.3	48.3	48.3
No. 4 Buck Mt.	27.9	48.0	39.0	12.8	30.7	25.5	50.8	68.7	64.5
No. 3 Lykens				44.1	44.1	44.1	93.0	93.0	93.0
A No. 2 Lykens				23.5	39.2	29.2	58.7	84.0	76.7
No. 1 Lykens	48.0	48.0	48.0	25.0	25.0	25.0	73.0	73.0	73.0
Total	--------	--------	37.7	--------	--------	26.3	--------	--------	64.0
Total for region	--------	--------	--------						
Estimated area, lowest bed	--------	--------	--------						

TABLE 6.—*Original and remaining reserves of coal and present recovery in the Western Middle Field, by beds in gross tons*

Name of bed		Estimated original tonnage	Per cent recovery	Average estimated amount of coal removed per year, tons	Estimated total amount of coal removed to date, tons	Estimated amount of coal remaining, tons
J.	Diamond	22,000,000	59.0	18,000	1,800,000	20,200,000
I.	Little Orchard	161,700,000	66.7	167,000	16,700,000	145,000,000
H.	Orchard	89.700,000	65.6	412,000	41,200,000	48,500,000
G.		318,000,000	65.2	294,000	20,580,000	297,420,000
	Primrose	93,000,000	67.5	106,000	10,600,000	82,400,000
F.	Holmes	25,180,000	73.0	537,000	53,700,000	404,980,000
		433,500,000	60.4			
E½		23,275,000	61.3	100,000	9,600,000	13,675,000
E.	Mammoth	86,200,000	66.1	125,000	10,000,000	76,200,000
		512,000,000	68.1	1,050,000	105,000,000	407,000,000
		594,000,000	67.8	1,030,000	123,000,000	471,000,000
		802,000,000	61.5	2,500,000	250,000,000	552,000,000
D.	Skidmore	219,000,000	69.0	433,000	43,300,000	175,700,000
C.	Seven Ft.	161,500,000	67.5	439,000	30,720,000	130,780,000
B.	Buck Mountain	581,000,000	64.1	1,900,000	190,000,000	391,000,000
		23,820,000	48.3	186,000	18,600,000	5,220,000
		343,500,000	64.5	496,000	49,600,000	293,900,000
A.	Lykens	7,640,000	93.0	60,000	3,600,000	4,040,000
		77,000,000	76.7	415,000	41,500,000	35,500,000
		22,780,000	73.0	61,000	4,270,000	18,510,000
	Total	4,596,795,000	64.0	10,389	1,023,770,000	3,573,025,000
	Pennsylvania Second Geological Survey	4,009,565,000				

Southern Field

The Southern Field has an area, according to the Second Geological Survey,[7] of 181 square miles. Reports from 16 out of 33 collieries in the Southern Field were procured, with an output of 4,858,810 tons, compared with a total production in 1921 of 11,112,197 tons, or 41.2 per cent. These collieries report a superficial area of the lowest bed amounting to 21,425 acres, shown in Table 7, compared with the total area of 115,840 acres underlain with coal. They have a total superficial area of coal amounting to 97,671 acres, compared with 527,000 acres for the whole field. They show only 38,519 acres developed, or 39.3 per cent of the total coal in the field.

The percentage of recovery by first mining in this field is the lowest of any, owing to the very steep pitching beds and the general character of the coal. The recovery by first mining amounts to only 29.1 per cent, with a minimum of 20.0 per cent and a maximum of 64.0 per cent. In the second mining, 24.7 per cent is the weighted average recovery, compared with the minimum of 9.9 per cent, and a maximum of 40.0 per cent. The total estimated weighted average recovery for the whole field is 53.8 per cent, with a minimum of 37.2 per cent, and a maximum of 90.0 per cent. Again it will be noted that the smallest recoveries are usually where the beds are thickest. For example, the Mammoth, with its 36 feet of thickness shows a recovery of only 48.1 per cent; whereas the Seven-foot bed, with a total thickness of 3 feet, 7 inches shows a recovery of 67.1 per cent.

As for the three other fields, an estimate was made of the original coal. In Table 8 this is shown to be 10,114,050,000 tons, compared with the estimate of 9,198,435,009 tons made by the Second Geological Survey.[6] It has been estimated that approximately 857,790,000 tons have been removed, leaving a balance of coal to be removed, of 9,256,260,000 tons. Assuming that the production will remain the same, it is estimated that there is sufficient coal in the Southern Field to last 408 years.

TABLE 7.—*Estimated area underlain with coal, developed area, thickness and recovery by beds, in the Southern Field*

Name of bed	Superficial area underlain with coal, acres	Estimated total superficial area underlain with coal, acres	Per cent of lowest bed	Area developed, acres	Per cent of superficial area	Coal produced in 1921, gross tons	Per cent of total	Per cent of region total	Average thickness of beds					
									Total		Partings		Coal	
									Ft.	In.	Ft.	In.	Ft.	In.
N. Peach Mt.	750	4,050	3.5	750	100.0	16,886	0.4	0.2	10	5	0	0	10	5
L. Little Tracy	800	4,300	3.7	800	100.0	43,647	0.9	0.4	6	10	1	1	5	9
K. Four Ft.	850	4,600	4.0	12	1.4	9,264	0.2	0.1	4	6	1	4	3	2
Tracy	1,628	8,800	7.6	1,628	100.0	155,791	3.2	1.4	7	4	2	[illegible]	4	.7
J. Little Diamond	500	2,700	2.3	239	47.8	11,822	0.2	0.1	7	8	2	11	4	9
Diamond	1,678	9,000	7.8	1,535	91.6	75,481	1.5	0.7	8	10	1	10	7	0
H. Orchard	8,841	47,800	41.3	1,228	13.9	198,794	4.1	1.8	8	2	0	10	7	4
G. Primrose	14,126	76,300	65.9	3,202	22.7	603,263	12.4	5.4	8	4	1	11	6	5
F. Holmes	2,369	12,800	11.1	2,355	99.5	124,820	2.6	1.1	8	6	2	5	6	1
E½	1,096	5,900	5.1	100	9.1	25,586	0.5	0.2	9	3	1	7	7	8
E. Top Mammoth	9,010	48,700	42.1	3,123	34.7	222,648	4.6	2.0	7	3	0	10	6	5
Mid Mammoth	6,049	32,700	28.3	878	14.5	203,945	4.2	1.8	7	4	0	11	6	5
Bot. Mammoth	7,938	42,900	37.1	3,168	40.0	377,698	7.8	3.4	8	3	0	11	7	4
Mammoth	8,012	43,300	37.4	2,409	30.1	1,621,263	33.4	14.6	36	0	6	11	29	1
D. Skidmore	3,483	45,900	39.6	3,434	40.5	75,391	1.5	0.7	5	7	1	1	4	3
C. Seven Ft.	6,778	36,600	31.6	2,601	38.4	77,794	1.6	0.7	3	7	[illegible]	9	2	10
B. Buck Mt.	11,828	63,900	55.3	5,393	45.6	501,636	10.3	4.5	7	5	2	0	5	0
Little Buck Mt.	654	3,530	3.1	447	68.4				13	2	6	[illegible]	[illegible]	11

TABLE 7.—*Estimated area underlain with coal, developed area, thickness and recovery by beds, in the Southern Field*—Continued

Name of bed	Superficial area underlain with coal, acres	Estimated total superficial area underlain with coal, acres	Per cent of lowest bed	Area developed, acres	Per cent of superficial area	Coal produced in 1921, gross tons	Per cent of total	Per cent of region total	Average thickness of beds					
									Total Ft.	Total In.	Partings Ft.	Partings In.	Coal Ft.	Coal In.
A. Big Vein	4,546	24,500	21.2	3,562	78.4	306,199	6.3	2.8	9	2	0	11	8	2
A. Little Vein	1,735	9,400	8.1	1,655	95.4	206,933	4.3	1.7	4	6	0	6	4	0
Total	97,671	527,680		38,519	39.5	4,858,810	100.0							
Estimated area, lowest bed	21,425	115,840												
Regional total						11,112,197								

Name of bed	Per cent recovery first mining			Per cent recovery second mining			Total per cent recovery		
	Minimum	Maximum	Weighted average	Minimum	Maximum	Weighted average	Minimum	Maximum	Weighted average
N. Peach Mt.	41.8	41.8	41.8	29.4	29.4	29.4	71.2	71.2	71.2
L. Little Tracy	41.6	41.6	41.6	29.3	29.3	29.3	70.9	70.9	70.9
K. Four Ft.	35.4	35.4	35.4	25.0	25 0	25.0	60.4	60.4	60.4
K. Tracy	41.1	42.1	41.2	28.7	28.9	28.9	69.0	71.5	70.1

J.	Little Diamond	33.6	33.6	33.6	24.0	24.0	24.0	57.6	57.6	57.6
	Diamond	34.7	41.4	37.8	25.1	29.3	27.0	59.8	70.7	64.8
H.	Orchard	20.0	45.0	21.4	17.2	30.0	17.9	37.2	75.0	39.3
G.	Primrose	25.3	45.0	29.0	20.0	31.6	25.0	48.1	70.4	54.0
F.	Holmes	39.4	64.0	40.5	28.2	28.8	28.7	40.0	71.0	69.2
E_2^1		45.0	45.0	45.0	40.0	40.0	40.0	85.0	85.0	85.0
E.	Top Mammoth	36.6	53.7	38.7	18.8	35.0	29.9	47.4	80.0	68.6
	Mid. Mammoth	33.6	50.0	34.6	15.0	40.0	30.7	48.6	90.0	61.3
	Bot. Mammoth	38.6	49.7	42.7	19.2	30.0	25.7	47.9	75.0	68.4
	Mammoth	25.5	48.8	25.7	19.5	22.4	22.4	47.4	68.3	48.1
D.	Skidmore	28.8	50.0	39.2	19.6	34.6	27.1	48.4	75.0	66.3
C.	Seven Ft.	33.6	60.0	35.9	15.0	33.6	31.2	53.2	84.2	67.1
B.	Buck Mt.	28.1	60.0	34.8	9.9	35.5	33.9	38.0	85.0	68.7
	Little Buck Mt.	48.7	48.7	48.7	0	0	0	48.7	48.7	48.7
A	Big Vein	34.5	39.3	36.9	26.8	38.4	32.6	66.1	72.9	69.5
	Little Vein	29.3	29.3	29.3	34.3	34.3	34.3	63.6	63.6	63.6
	Total			29.1			24.7			53.8

TABLE 8.—*Original and remaining reserves of coal and present recovery in Southern Field, by beds, in gross tons*

Name of bed	Estimated original tonnage	Per cent re-covery	Average estimated amount of coal removed per year, tons	Estimated total amount coal removed to date, tons	Estimated amount of coal remaining, tons
N. Peach Mountain	103,500,000	71.2	21,000	1,680,000	101,820,000
L. Little Tracy	61,100,000	70.9	53,000	4,240,000	56,860,000
K. Big Tracy	135,500,000	60.4	241,000	19,280,000	116,220,000
J. Diamond	29,600,000	70.1	15,000	900,000	28,700,000
	167,250,000	1.2	108,000	8,640,000	158,610,000
I. Little Diamond					
H. Orchard	1,022,500,000	39.3	492,000	39,360,000	983,140,000
G. Primrose	1,197,600,000	54.0	1,130,000	101,700,000	1,095,300,000
F. Holmes	228,800,000	69.2	178,000	17,800,000	211,000,000
E. Mammoth	559,000,000	68.6	320,000	32,000,000	527,000,000
	601,000,000	61.3	334,000	33,400,000	567,600,000
	588,000,000	68.4	540,000	54,000,000	534,000,000
	2,550,000,000	48.4	3,490,000	349,000,000	2,201,000,000
D. Skidmore	566,000,000	66.3	112,000	7,840,000	558,160,000
C. Seven Ft.	272,500,000	67.1	115,000	7,840,000	558,160,000
B. Buck Mountain	929,000,000	68.7	1,060,000	106,000,000	881,200,000
	58,200,000	48.7			
A. Lykens	883,000,000	69.5	437,000	43,700,000	839,300,000
	162,000,000	63.6	325,000	32,500,000	129,500,000
Total	10,114,050,000	53.8	5,207,600	857,790,000	9,256,260,000
Pennsylvania Second Geological Survey	9,198,435,000				

FACTORS INFLUENCING EXTRACTION OF COAL

Three principal factors influence the amount of coal that can be recovered—namely, (1) the thickness of beds; (2) the depth below the surface; and (3) the pitch. These will be discussed by fields in the following pages.

Northern Field

Thickness of beds. The thickness of a bed partly determines the quantity of coal that has to be left behind for the support of the roof. In a thin bed the pillars need not be as large as in a thick bed, therefore, it would be natural to expect that the percentage of recovery would be greater for the thin beds than it would be for the thick beds. Table 9 gives the thickness of beds in the Northern

Field, and the last column shows that for beds 7 feet and under the recovery is over 70.0 per cent. In fact, with the exception of the interval of 7 to 8 feet, this is true up to a thickness of 10 feet; then the percentage of recovery decreases as the thickness of the bed increases. In the bed 18 to 20 feet thick the estimated recovery is 71.7 per cent, but this figure is from a colliery at which the recovery is high, so the figure is really abnormal. The thickest beds of all, between 25 and 30 feet, show a total recovery of only 55.3 per cent, compared to an average for the field of 70.7 per cent.

Depth of workings. The percentage of recovery is also influenced by the depth of workings, as was shown in the discussion of Table 1. Owing to the peculiar conditions in the Northern Field, as previously explained, Table 10, showing the recovery by depth, does not bring this point out as well as might be expected. In the Northern Field in particular the shallow depths of the beds favors a high recovery, but this favorable condition is offset somewhat by the necessity of leaving coal where mine workings approach the Buried Valley which occupies part of the field. However, generally speaking, the recovery is slightly less where the depth is greatest.

Pitch of beds. Besides depth and thickness, pitch has a considerable influence upon production, but in the Northern Field, as practically all of the companies reported, the general pitch is less than 15 degrees, and has had no appreciable effect on the rate of recovery.

TABLE 9.—*Recovery in relation to thickness of beds in the Northern Field.*

Thickness of beds, feet	Coal produced, gross tons	Per cent of total	Superficial area of coal, acres	Per cent of total	Developed area of beds, acres	Per cent superficial area	Per cent recovered first mining			Per cent recovered second mining			Total per cent recovered		
							Minimum	Maximum	Wt'd. average	Minimum	Maximum	Wt'd. average	Minimum	Maximum	Wt'd average
Under 3	570,352	3.2	12,571	7.5	3,064	24.4	32.8	90.0	49.4	5.5	32.0	24.8	32.8	90.0	74.2
3 — 4	1,880,726	10.6	16,503	9.9	8,265	50.1	18.1	90.0	52.0	7.3	46.3	26.3	27.0	91.2	78.3
4 — 5	2,958,830	16.7	28,827	17.3	13,005	45.1	26.5	65.7	52.2	10.6	36.9	18.7	26.5	91.1	70.9
5 — 6	3,528,178	19.9	36,522	21.9	18,288	50.0	22.6	90.0	59.0	1.2	32.0	15.8	29.0	90.0	74.8
6 — 7	1,803,292	10.2	15,946	9.5	13,310	83.7	33.3	65.7	51.8	9.0	33.7	20.4	50.1	93.3	72.2
7 — 8	608,291	3.4	14,464	8.7	9,501	65.7	29.7	63.0	45.4	8.3	31.8	13.9	46.2	81.7	59.3
8 — 9	1,398,314	7.9	13,618	8.2	10,872	80.0	34.4	60.8	54.0	10.0	31.9	20.3	34.4	88.7	74.3
9 — 10	1,274,032	7.2	6,995	4.2	5,749	82.6	33.0	66.3	58.7	6.2	43.5	15.2	40.4	85.5	73.9
10 — 12	1,627,562	9.1	8,743	5.2	6,333	72.5	37.2	75.0	45.6	10.0	35.0	17.9	54.1	88.5	63.5
12 — 14	1,726,268	9.7	9,857	5.9	7,366	74.7	19.8	90.0	45.8	4.5	36.4	26.0	19.8	92.0	71.8
16 — 18	165,689	0.9	1,593	1.0	1,561	98.0	47.5	59.7	49.5	0.6	15.5	12.3	60.3	63.0	61.8
18 — 20	100,393	0.6	618	0.4	451	72.9	46.5	48.0	47.6	23.8	25.8	24.1	71.6	72.3	71.7
25 — 30	104,079	0.6	565	0.3	428	75.8	42.3	42.3	42.3	13.0	13.0	13.0	55.3	55.3	55.3
Total	17,746,006	100.0	166,822	70.0	97,193	58.6	-------	-------	49.5	-------	-------	21.2	-------	-------	70.7

TABLE 10.—*Recovery in relation to depth of workings in the Northern Field.*

Depth of beds, feet	Coal produced, gross tons	Per cent of total	Superficial area of coal, acres	Per cent of total	Developed area of beds, acres	Per cent superficial area	Per cent recovered first mining			Per cent recovered second mining			Total per cent recovered		
							Minimum	Maximum	Wt'd. average	Minimum	Maximum	Wt'd. average	Minimum	Maximum	Wt'd. average
Under 100	511,257	2.5	2,621	1.3	2,317	88.4	19.2	90.0	47.3	4.5	31.6	19.8	19.8	90.0	67.1
100 — 200	3,329,613	16.1	26,573	12.6	19,977	75.4	33.0	90.0	57.2	5.6	33.7	19.8	33.0	90.0	77.0
200 — 300	3,484,881	16.8	29,200	13.9	17,414	59.6	38.6	90.0	50.4	6.4	33.9	21.6	45.0	93.9	72.0
300 — 400	2,962,861	14.3	24,972	11.8	14,677	58.9	24.6	63.6	45.5	2.0	31.9	21.1	32.8	86.9	66.6
400 — 500	2,956,673	14.3	26,483	12.5	16,701	63.2	34.8	65.0	52.2	3.8	33.7	15.7	42.0	88.7	67.9
500 — 600	564,344	2.8	15,140	7.2	7,669	50.5	33.9	63.4	47.3	1.2	30.1	13.1	42.8	77.5	60.4
600 — 700	1,263,449	6.1	9,589	4.5	4,624	48.3	42.6	54.3	52.4	17.6	30.7	18.5	42.6	80.7	70.9
700 — 800	2,023,581	9.8	20,026	9.5	7,660	38.2	29.7	55.0	52.8	11.6	34.9	25.0	46.2	79.9	77.8
800 — 900	721,317	3.5	15,346	7.3	6,909	45.1	29.4	55.0	51.2	16.5	36.4	20.8	62.9	81.3	72.0
900 — 1000	481,711	2.3	5,803	2.3	3,436	57.6	39.6	55.0	52.2	10.5	36.8	12.5	66.5	76.9	67.5
1000 — 1100	1,375,117	6.7	23.981	11.3	7,355	30.7	34.6	55.0	46.3	17.9	31.5	19.8	66.1	78.8	66.1
1100 — 1200	661,463	3.2	10,127	4.3	4,509	44.4	45.0	48.7	47.2	25.8	34.1	26.8	70.8	79.8	73.0
1200 — 1300	292,485	1.4	3,082	1.5	2,888	93.8	45.7	54.1	50.8	16.0	19.0	17.8	61.7	73.1	68.6
Total	20,628,752	100.0	212,943	100.0	116,136	55.0	------	------	------	------	------	------	------	------	------

4mm

Eastern Middle Field

Thickness of beds and depth of workings. In the Eastern Middle Field the beds lie in comparatively heavy pitches, so it is not to be expected that depth of workings has as much influence as in flat-lying beds. This is brought out by Table 11, which shows no general tendency for the percentage of recovery to decrease with the depth of working. However, in Table 12 which shows the recovery by thickness of beds in this field the reader will note that the recovery is generally less in the thicker beds than in the thinner beds. Those beds between 18 and 20 feet in thickness which show such a high percentage of recovery are beds mined by stripping, therefore the high percentage. This also applies to the beds between 9 and 10 feet thick. If allowance for these two exceptions is made, the percentage of recovery for the thicker beds becomes less than that for the thinner beds.

Pitch of beds. Percentage of recovery with relation to pitch in the Eastern Middle Field (see Table 13) shows the greatest recovery on one of the heaviest pitches, but as practically all of the coal considered in this pitch comes from two mines that have large stripping operations, which increased the percentage of recovery, beds of 40 to 45 degrees pitch appear to have a greater recovery than beds with higher or lower pitches.

TABLE 11.—*Recovery in relation to depth of workings in the Eastern Middle Field.*

Depth of beds, feet	Coal produced, gross tons	Per cent of total	Superficial area of coal, acres	Per cent of total	Developed area of beds, acres	Per cent superficial area	Per cent recovered first mining			Per cent recovered second mining			Total per cent recovered		
							Minimum	Maxi mum	Wt'd. average	Minimum	Maximum	Wt'd. average	Minimum	Maximum	Wt'd. average
0 — 100	----------	--------	15	--------	10	66.7	55.0	60.0	57.5	25.0	25.0	25.0	80.0	85.0	82.5
100 — 200	336,392	10.4	1,923	7.8	1,723	89.7	40.0	64.0	63.9	--------	24.1	7.0	64.0	88.4	70.9
200 — 300	669,940	20.9	6,018	24.5	5,252	87.3	39.6	63.0	55.1	18.3	34.9	23.5	68.4	92.2	78.9
300 — 400	1,131,680	35.1	5,195	21.0	4,374	84.2	42.7	90.0	48.3	--------	40.0	27.9	64.5	90.0	76.2
400 — 500	688,121	21.4	6,065	24.6	4,245	70.0	33.2	50.0	47.7	12.7	33.9	24.6	49.5	85.0	72.3
500 — 600	272,754	8.5	3,035	12.3	2,149	70.8	55.0	55.0	55.0	19.4	33.7	24.9	69.1	88.7	79.9
600 — 700	119,117	3.7	2,427	9.8	2,143	88.4	50.0	55.0	51.6	16.2	25.5	22.1	66.2	80.5	75.5
Total	3,218,004	100.0	24,678	100.0	19,896	80.7	--------	--------	--------	--------	--------	--------	--------	--------	73.7

TABLE 12.—*Recovery in relation to thickness of beds in the Eastern Middle Field.*

Thickness of beds, feet	Coal produced, gross tons	Per cent of total	Superficial area of coal, acres	Per cent of total	Developed area of beds, acres	Per cent superficial area	Per cent recovered first mining			Per cent recovered second mining			Total per cent recovered		
							Minimum	Maximum	Wt'd. average	Minimum	Maximum	Wt'd. average	Minimum	Maximum	Wt'd. average
Under 3	75,501	2.1	462	1.9	196	36.6	37.6	55.0	51.0	21.9	30.9	33.9	71.2	85.0	84.8
3 — 4	163,900	4.6	302	1.2	302	100.0	33.2	60.0	45.5	16.3	34.0	29.7	49.5	85.0	75.2
4 — 5	600,055	17.0	7,218	29.4	3,140	43.5	45.0	64.0	54.0	19.4	40.0	26.3	67.3	88.3	80.3
5 — 6	97,549	2.8	1,557	6.3	1,198	77.0	50.0	50.0	50.0	16.2	19.5	17.5	66.2	69.5	67.5
6 — 7	653,124	18.5	5,366	21.9	3,269	61.0	41.8	64.0	51.9	19.4	33.7	23.9	69.4	88.4	75.8
7 — 8	357,050	10.1	2,617	10.6	2,392	91.4	46.0	90.0	57.3	0.0	33.7	24.4	64.1	90.0	81.7
8 — 9	16,750	0.5	323	1.3	232	72.0	50.0	50.0	50.0	22.6	22.6	22.6	72.6	72.6	72.6
9 — 10	247,033	7.0	1,380	5.6	1,256	91.0	64.0	64.0	64.0	24.7	24.7	24.7	88.7	88.7	88.7
12 — 14	133,918	3.8	1,095	4.4	915	83.6	43.7	64.0	40.7	25.0	29.2	29.0	72.9	39.0	69.7
14 — 16	291,800	8.2	1,544	6.3	822	72.0	44.0	44.0	44.0	29.4	29.4	29.4	73.4	73.4	73.4
18 — 20	93,502	2.6	125	0.5	102	81.6	60.2	60.2	60.2	23.1	23.1	23.1	83.3	83.3	83.3
20 — 25	399,600	11.3	761	3.1	710	93.5	39.3	55.0	50.9	21.6	24.9	24.0	60.9	79.9	74.9
30 and over	408,184	11.5	1,853	7.5	1,782	96.2	50.0	90.0	50.3	12.7	33.8	17.1	62.7	90.0	67.4
Total	3,537,995	100.0	24,603	100.0	16,316	66.3	--------	--------	49.0	--------	--------	24.7	--------	--------	73.7

TABLE 13.—*Recovery in relation to pitch in the Eastern Middle Field.*

Pitch of beds, degrees	Coal produced, gross tons	Per cent of total	Superficial area of coal, acres	Per cent of total	Developed area of beds, acres	Per cent superficial area	Per cent recovered first mining			Per cent recovered second mining			Total per cent recovered		
							Minimum	Maximum	Wt'd. average	Minimum	Maximum	Wt'd. average	Minimum	Maximum	Wt'd. average
20 — 25	221,040	7.1	1,915	9.1	1,526	79.7	40.3	50.0	42.6	15.8	40 0	29.9	65.8	85.0	72.5
35 — 40	555,969	17.9	4,196	20.0	2,353	56.2	50.0	90.0	57.9	16.8	24 8	22.8	66.8	90.0	80.7
40 — 45	349,701	11.3	5,360	25.6	4,125	76.9	50.0	50.0	50.0	12.7	20.4	16.4	62.7	70.4	66.4
45 — 50	331,549	10.7	1,951	9.3	1,660	84.6	58.0	63.0	60.0	23.1	25.0	23.5	71.1	87.0	83.5
50 — 55	1,643,234	53.0	7,540	36.0	5,173	68.6	39.3	64.0	49.8	21.6	34.0	21.7	60.9	85.0	74.5
Total	3,099,493	100.0	20,972	100.0	14,837	70.0	--------	--------	49.0	--------	--------	21.7	--------	--------	73.7

Western Middle Field

Thickness of beds, depth of workings, and pitch of beds. In the Western Middle Field the recovery in the thick beds, as shown in Table 14, is considerably less than in the thin beds, confirming the former statements of similar character. As the beds increase in depth, Table 15 shows a marked decrease in production in those beds that lie at greater depths than 600 feet. In fact, the decrease in production is almost uniform; but when we consider the recovery in relation to the degree of pitch (See Table 16), we find that pitch seems to make little difference in the percentage of recovery, because some beds having the greatest pitch show the greatest recovery, while others having the least pitch show the least recovery. Generally speaking, all of the work in this field is breast mining.

TABLE 14.—*Recovery in relation to thickness of beds in the Western Middle Field.*

Thickness of beds, feet	Coal produced, gross tons	Per cent of total	Superficial area of coal, acres	Per cent of total	Developed area of beds, acres	Per cent superficial area	Per cent recovered first mining			Per cent recovered second mining			Total per cent recovered		
							Minimum	Maximum	Wt'd. average	Minimum	Maximum	Wt'd. average	Minimum	Maximum	Wt'd. average
Under 3	42,412	0.9	2,286	3.0	286	12.5	35.2	48.0	38.0	25.0	32.0	24.5	58.7	73.0	62.5
3 — 4	288,147	6.2	4,782	6.4	3,051	63.8	32.8	48.9	38.6	18.9	44.1	29.9	48.9	93.0	68.5
4 — 5	527,205	11.4	12,199	16.4	4,827	39.5	32.8	50.0	40.4	21.8	30.4	25.0	56.1	73.0	65.4
5 — 6	238,755	5.1	7,388	9.9	4,900	66.3	27.6	50.0	38.5	16.0	39.2	28.6	50.0	82.3	67.1
6 — 7	607,724	13.0	9,081	12.2	6,238	68.6	27.2	50.0	39.1	12.3	30.5	25.8	45.0	79.2	64.9
7 — 8	429,386	9.2	13,236	17.8	7,127	53.8	27.1	48.0	36.8	22.2	32.0	26.4	49.3	73.3	63.2
8 — 9	537,282	11.5	8,369	11.3	5,876	70.2	32.9	50.0	40.1	15.4	40.1	30.3	65.7	85.8	70.4
9 — 10	214,549	4.6	4,616	6.2	1,699	36.9	31.9	45.0	36.1	16.0	46.4	27.7	60.3	84.8	63.8
10 — 12	387,965	8.4	4,574	6.1	3,303	72.3	35.7	50.0	41.7	14.7	32.0	30.1	37.0	84.0	71.8
12 — 14	264,648	5.7	2,537	3.5	2,422	95.1	27.9	40.0	34.7	19.7	31.5	27.9	47.6	71.1	62.6
16 — 18	530,181	11.6	2,722	3.6	2,204	80.9	26.7	68.5	42.2	19.2	31.7	26.2	48.7	86.2	68.4
18 — 20	93,600	2.0	283	0.3	283	100.0	38.0	38.0	38.0	30.8	30.8	30.8	30.8	38.0	68.0
20 — 25	99,000	2.1	1,380	1.8	1,200	86.9	25.1	33.5	33.6	20.6	29.9	29.9	45.7	63.5	63.5
25 — 30	151,500	3.3	843	1.1	191	58.2	35.0	48.0	46.1	18.8	29.7	20.3	61.7	66.8	68.3
30 and over	235,000	5.0	359	0.4	359	100.0	45.3	45.3	45.3	23.6	23.6	23.6	23.6	45.3	68.9
Total	4,647,381	100.0	74,655	100.0	44,266	59.2									

TABLE 15.—*Recovery in relation to depth of workings in the Western Middle Field.*

Depth of beds, feet	Coal produced, gross tons	Per cent of total	Superficial area of coal, acres	Per cent of total	Developed area of bed, acres	Per cent superficial area	Per cent recovered first mining			Per cent recovered second mining			Total per cent recovered		
							Minimum	Maximum	Wt'd. average	Minimum	Maximum	Wt'd. average	Minimum	Maximum	Wt'd average
100—200	413,370	20.5	3,206	11.3	1,696	52.9	35.2	60.0	43.0	17.0	46.4	29.2	59.3	84.6	71.2
200—300	236,375	11.8	5,486	19.3	1,558	28.4	35.2	60.0	36.7	19.2	26.4	24.3	58.7	79.2	61.0
300—400	141,849	7.0	699	2.4	523	74.8	35.0	50.0	37.7	11.5	29.7	29.0	57.0	68.5	66.7
400—500	182,067	9.0	3,824	13.5	2,385	62.3	40.0	50.0	41.0	19.6	39.2	27.7	61.5	82.3	68.7
500—600	618,568	32.0	8,575	30.2	4,051	47.2	32.9	50.0	45.6	17.1	34.2	29.5	50.6	84.2	75.1
600—700	49,258	2.4	1,839	6.4	1,749	95.1	44.0	45.0	44.0	25.7	39.1	29.1	70.7	73.3	73.4
700—800	219,847	10.8	1,467	5.1	913	62.2	45.0	50.0	47.2	16.0	31.1	23.1	45.0	81.1	70.3
800—900	95,539	4.7	822	2.8	416	50.6	39.7	45.0	42.5	26.4	28.3	27.5	66.1	73.3	70.0
900—1000	0	0	600	2.1	521	86.8	40.0	40.0	40.0	28.7	28.7	28.7	28.7	40.0	68.7
1100—1200	37,615	1.8	1,950	6.9	882	45.2	35.2	35.2	35.2	23.5	23.5	23.5	23.5	35.2	58.7
Total	2,024,488		28,468	100.0	11,694	51.2									

TABLE 16.—*Recovery in relation to pitch in the Western Middle Field.*

Pitch of beds, degrees	Coal produced, gross tons	Per cent of total	Superficial area of coal, acres	Per cent of total	Developed area of beds, acres	Per cent superficial area	Per cent recovered first mining			Per cent recovered second mining			Total per cent recovered		
							Minimum	Maximum	Wt'd. average	Minimum	Maximum	Wt'd. average	Minimum	Maximum	Wt'd. average
20—25	209,668	4.6	2,256	3.0	2.103	93.2	32.9	48.0	36.3	12.8	26.2	19.2	48.3	65.9	55.5
30—35	209.193	4.5	1,415	1.9	416	29.4	34.8	31.6	45.7	34.6	46.4	39.0	73.0	82.3	84.7
35—40	871,819	19.0	15,225	20.8	5,827	38.3	35.2	60.0	39.0	19.2	31.7	25.2	58.7	84.0	64.2
40—45	1,533,462	33.5	34,114	46.7	23,059	67.6	27.2	48.0	39.0	17.9	39.1	28.9	45.0	83.1	67.9
45—50	768,317	16.7	6,951	9.4	2,956	45.4	27.1	50.0	32.0	12.3	28.9	20.5	47.2	68.9	52.5
55—60	889,955	19.4	12,375	17.0	5,600	45.3	31.5	50.0	46.8	17.1	34.2	29.1	59.5	81.2	75.9
60—65	103,130	2.3	649	0.9	521	80.4	35.0	39.2	37.2	20.0	31.6	29.9	57.0	73.6	67.1
Total	4,585.574	100.0	72,985	100.0	40,482	55.2									

Southern Field

Thickness of beds, depth of workings, and pitch of beds. Table 17 brings out clearly the decrease in production with the increase in thickness of beds in the Southern Field. The production of all beds from 10 feet and over averages approximately 49 per cent recovery as against the recovery of between 60 and 70 per cent in thinner beds. Unfortunately, data were insufficient to determine the influence of the depth of workings on recovery in the Southern Field, but information was obtained on the effect of pitch. Table 18 shows that the least recovery is in those pitches between 35 and 40 degrees and 50 and 55 degrees. But this is mainly due to the fact that the collieries reporting these pitches lie at the ends of the field and do not really indicate the general average of the field.

TABLE 17.—*Recovery in relation to thickness of beds in the Southern Field.*

Thickness of bed, feet	Coal produced, gross tons	Per cent of total	Superficial area of coal, acres	Per cent of total	Developed area of beds, acres	Per cent superficial area	first mining Per cent recovered			second mining Per cent recovered			recovered Total per cent		
							Minimum	Maximum	Wt'd. average	Minimum	Maximum	Wt'd. average	Minimum	Maximum	Wt'd. average
Under 3	56,861	1.2	5,883	6.1	1,209	20.5	36.6	60.0	38.4	15.0	30.2	29.1	66.8	75.0	67.5
3—4	50,054	1.0	2,610	2.7	1,912	73.2	39.4	50.6	40.9	0.0	35.5	31.0	50.6	74.9	71.9
4—5	461,729	9.6	16,415	17.0	4,282	26.0	29.3	47.5	39.4	18.9	40.9	31.3	60.4	85.6	70.7
5—6	229,512	4.7	12,260	12.8	3,934	32.0	28.8	60.0	33.1	12.8	33.6	30.0	48.5	75.0	63.1
6—7	126,622	2.6	3,870	4.0	1,669	43.1	36.6	47.4	41.6	18.8	35.0	28.0	65.0	75.0	69.6
7—8	461,693	9.6	14,016	14.6	7,143	50.9	20.0	64.0	25.7	0	29.3	19.8	37.2	70.8	45.5
8—9	611,835	12.7	9,567	10.0	6,452	67.4	31.5	50.0	36.0	15.0	48.0	36.5	65.0	82.5	72.5
9—10	468,064	9.7	11,905	12.4	4,122	34.6	34.2	48.5	35.2	0	34.2	32.9	45.0	70.4	68.1
10—12	499,627	10.3	10,863	11.3	4,453	40.9	25.3	49.5	26.0	0	29.4	23.0	48.1	71.2	49.0
12—14	207,684	4.3	764	0.8	517	71.5	48.0	53.7	49.0	0	19.2	1.6	48.7	67.2	50.7
30 and over	1,664,271	34.3	8,012	8.3	2,409	30.0	22.4	48.8	25.7	19.5	25.5	22.4	47.9	68.3	48.1
Total	4,846,955	100.0	96,170	100.0	38,132	100.0			29.1			24.7			53.8

TABLE 18.—*Recovery in relation to pitch in the Southern Field.*

Pitch of beds, degrees	Coal produced, gross tons	Per cent of total	Superficial area of coal, acres	Per cent of total	Developed area of beds, acres	Per cent superficial area	Per cent recovered first mining			Per cent recovered second mining			Total per cent recovered		
							Minimum	Maximum	Wt'd. average	Minimum	Maximum	Wt'd. average	Minimum	Maximum	Wt'd. average
35—40	303,600	6.3	2,502	3.7	1,375	54.9	45.0	53.7	49.0	0	0	0	45.0	55.7	49.0
40—45	12,822	0.3	705	0.8	85	12.1	49.4	49.4	49.4	19.7	19.7	19.7	69.1	69.1	69.1
45—50	883,981	18.4	15,813	17.1	9,237	58.3	32.1	60.0	42.2	12.8	33.6	25.6	44.9	75.5	67.8
50—55	2,346,947	48.8	34,711	37.5	6,910	19.9	20.0	49.2	26.2	17.2	35.0	23.2	37.2	80.0	49.4
55—60	218,717	4.6	4,526	4.9	5,688	81.7	35.4	41.8	41.0	25.0	29.4	28.9	60.4	71.2	69.9
65—70	1,040,886	21.6	34,136	37.0	13,668	40.2	28.1	42.1	36.2	9.9	48.0	35.4	36.0	82.5	69.6
Total	4,806,253	100.0	92,393	100.0	34,963	37.9			29.1			24.7			53.8

LOSS IN PREPARATION

It has been impossible to secure detailed figures as to the loss of coal in preparation, because many companies reported the losses lumped together. These various losses have been discussed in the abstract in the preliminary part of this report. In the Northern field the loss in preparation amounts to 3.7 per cent; in the Eastern Middle field it amounts to 4.3 per cent; in the Western Middle Field it increases to 5.9 per cent, and in the Southern Field is 4.8 per cent. Of course, the largest part of these losses is due to the small sizes of coal which are not at the present time commercially valuable.

RESERVES OF ANTHRACITE AND TENDENCY OF RECOVERY

Northern Field

By examining the column headed "Developed area, percent of superficial area" in Table 9, showing thickness of beds in the Northern Field, it will be seen that the future coal will come from thinner beds, that is, beds up to 6 feet in thickness. Referring to the same column in Table 10, "Recovery by depth of workings," it will be noted that the future recovery will be in the deeper beds. This means that in the first place we may look for an increased recovery due to thinner beds being mined at greater depths, which may or may not counterbalance each other, and leave the recovery in the future similar to that at the present, providing that there is no change in mining conditions. This brings us to a study of the estimated amount of coal remaining in the Northern Field, as shown in Table 2. Here it will again be observed that whatever reserves there are in this field, they will be found mainly in beds lying below the "F" bed, and the greatest production can be expected from the Baltimore and Red Ash beds, which have so far been the great producers.

Eastern Middle Field

As in the Northern Field, the indications are that the greatest reserves in the Eastern Middle Field are in the thick beds, which show the lowest percentage of recovery, so that it is reasonable to expect that in the future, mining conditions remaining the same, the percentage of recovery will possibly decrease in this field, especially as the coal that is recoverable by stripping is nearly exhausted. As previously shown, the depth of workings in this field has little influence upon the recovery, as the field itself is comparatively shallow. Generally speaking, the field consists almost entirely of pitching measures. The greatest reserves will come from those pitches which lie between 35 and 40 degrees; and as pitch in this region seems to have little regular effect on recovery, it is to be expected that there will be little change in the percentage of recovery due to the pitch on which the coal is mined. To one studying the reserve in Table 4, it seems that the greatest recovery in the future will probably be from the Mammoth bed, which is the thick bed of the region, while the next greatest recovery will be from the Buck Mountain bed. These two beds, however, rank among the thick beds of the region, and show the smallest percentage of recovery. Therefore, with the present conditions continuing, it is possible that the rate of recovery will tend to decrease.

Western Middle Field

In considering future supply and the probable effect of demand on the present rate of recovery, assuming that the methods of mining do not change, one may expect that this supply will be derived from the thinner beds, which will probably show an increased rate of recovery. It is indicated that future coal will come from beds at not very great depth, so that the recovery will be increased by this cause also. From Table 6 it will be seen that the great reserves in this region are in the Mammoth or "E" bed, and the Holmes or "F" bed, the deeper beds having been worked to a much greater degree than the shallow beds. Therefore, it is possible to expect that in the Western Middle Field there will be a general increase in the percentage of recovery, with mining conditions remaining the same.

Southern Field

It is practically impossible to determine what the effect will be on the percentage of recovery in the Southern Field, as that field has hardly been touched, if the amount of coal removed is compared with the amount remaining. The great reserves of anthracite lie in this field, but the indications are that the greatest amount of coal will come from the Mammoth bed and its splits; also from the Primrose and Orchard beds. These beds are all comparatively thick, so it may be possible that the recovery, under the present mining systems, will not be increased.

SUMMARY.

In 1880, Joseph S. Harris, an engineer for the Philadelphia & Reading Coal & Iron Co., the largest producers of anthracite, called attention to an estimated recovery of 38.7 per cent in a certain measured section of the property of the Lehigh Coal & Navigation Co., and estimated the recovery for the Reading property at 27 per cent. Mr. Gowan, then president of the same company, criticised this estimated recovery by saying:

> Twenty-seven per cent of the coal in the ground, or 400 tons per acre for every one foot in thickness of coal seams is much less than can be taken to market. It is probably true that in its past, under wasteful systems of mining, especially in large veins, but from 20 to 25 per cent of the coal in the ground was sent to market; but in those days the pea and buckwheat, and sometimes the chestnut, were thrown on the culm pile. —It is in my judgment fair to assume that in the future when all the smaller sizes, and even the culm itself, will be merchantable, more than 50 per cent; and in the present at least, 40 per cent of the coal in the ground can and will be sent to market.

These figures are indicative of what has occurred in the past in mining. By improved methods there has been a considerable improvement in recovery during the last 20 years, as shown in Table 19.

TABLE 19—*Percentage of recovery and loss as in 1921.*

Field	Mining Recovery in percentage of original coal content.			Loss in percentage of original coal content.		
	First mining	Second mining	Total	In mining	In preparation	Total
Northern	49.5	21.2	70.7	29.3	3.7	33.0
Eastern Middle	49.0	24.7	73.7	26.3	4.3	30.6
Western Middle	37.7	26.3	64.0	36.0	5.9	41.9
Southern	29.1	24.7	53.8	46.2	4.8	51.0
Total region	40.9	24.5	65.4	34.6	4.3	38.9

The above table indicates that at present the estimated weighted average recovery by first mining in the whole anthracite region is 40.9 per cent; the second mining, 24.5 per cent, and the total underground recovery amounts to 65.4 per cent. As there is a loss in preparation of 4.3 per cent, the total coal recovered for the whole region amounts to 61.1 per cent; in other words, the total loss is 38.9 per cent. These data are based on figures shown in Table 20 procured from 91 collieries out of the 244 in the anthracite region, or 37.3 per cent of the total. These collieries in 1921 produced 39,676,345 tons or 49.1 per cent of the total production for the region. They have a total superficial area of all beds of 452.999 acres out of a total of 1,418,400 acres, and have a developed area of 234,752 acres, or the total development of the region is shown to be 51.9 per cent. In the preparation of the data for this report, it was found that the estimated total original coal in the region was 20,770,916,000 tons, which compares with an estimate of 19,507,872,000 tons made by the Second Geological Survey of Pennsylvania.[6] It is also estimated that of the original coal, 4,416,240,000 tons have been removed to date, and 16,354,676,000 tons remain in the ground. At the present rate of production, this will last 124 years. This indicates an exhaustion at the rate of mining of 131,500,000 tons per year based on the figures for 1921.

It is possible that this recovery of coal can be increased by the more general adoption in the Northern Field of longwall methods of mining, which have been successfully employed in some mines; also by the further development of some economical method of silting (hydraulic filling) the first mined areas under the Buried Valley and under built-up or occupied portions of the anthracite region. It may be possible to increase the percentage of recovery by the adoption of different types of mining in the Southern, Eastern and Western Middle Fields. More careful design in breaker construction could eliminate to some extent the amount of degradation that occurs, and the possible installation of devices for handling coal might also decrease this loss.

The consumption of the fine sizes in the form of briquet or powdered fuel, and the more extensive use of mechanical stokers, can probably increase the use of the extremely fine sizes, and therefore decrease the loss from this source.

With present conditions continuing in the future, we may look for a possible falling off in the percentage of recovery; but the indications are that more extensive employment of the best mining practice may result in an increase in the percentage of recovery. Therefore, it seems reasonable to believe that the percentage of recovery will not decrease, but probably may increase slightly.

TABLE 20.—*Summary: Total and developed areas, recovery, reserves, water handled, and totals for whole Anthracite Region.*

	Unit	Northern Field	Eastern Middle Field	Western Middle Field	Southern Field	Anthracite Region
Collieries reporting	Number	48	11	16	16	91
Total number of collieries		133	27	51	33	244
(a) Tons of coal produced at collieries furnishing information—1921	Gross tons	23,665,829	4,315,613	5,126,294	6,268,609	39,676,345
Tons of coal produced at all collieries	Gross tons	45,911,000	6,958,000	16,695,071	11,112,197	80,676,268
Superficial area of coal, all beds, as reported	Acres	249,011	24,909	81,408	97,671	452,999
Superficial area of coal, estimated for whole region	Acres	550,000	48,600	292,800	527,000	1,418,400
Superficial area of coal, reported developed	Acres	130,802	19,705	45,726	38,519	234,752
Superficial area of coal, estimated developed	Acres	289,000	38,500	163,900	207,800	699,200
Developed to superficial area	Per cent	52.6	79.2	56.2	39.3	51.9
Recovery by first mining	Per cent	49.5	49.0	37.7	29.1	40.9
Recovery by second mining	Per cent	21.2	24.7	26.3	24.7	24.5
Total mining recovery	Per cent	70.7	73.7	64.0	53.8	65.4
Loss in preparation	Per cent	3.7	4.3	5.9	4.8	4.3
Total recovery	Per cent	67.0	69.4	58.1	49.0	61.1
Total loss	Per cent	33.0	30.6	41.9	51.0	38.9
Estimated original content of bed by Second Pennsylvania Geological Survey	Gross tons	5,697,381,000	602,491,000	4,009,565,000	9,198,435,000	19,507,872,000

TABLE 20.—*Summary: Total and developed areas, recovery, reserves, water handled, and totals for whole Anthracite Region*—Concluded

	Unit	Northern Field	Eastern Middle Field	Western Middle Field	Southern Field	Anthracite Region
Estimated original content of bed—present estimate	Gross tons	5,447,623,000	612,448,000	4,596,795,000	10,114,050,000	20,770,916,000
Estimated contents removed	Gross tons	2,170,860,000	363,820,000	1,023,770,000	857,790,000	4,416,240,000
Estimated remaining contents	Gross tons	3,276,763,000	248,628,000	3,573,025,000	9,256,260,000	16,354,676,000
Number of pumps pumping to surface, reporting collieries	Number	225	59	71	50	405
Number of pumps pumping to surface.—total	Number	460	111	213	108	892
Capacity reported	Gallons per min.	162,065	68,750	65,603	48,883	345,301
Capacity whole field	Gallons per min.	336,362	113,116	126,258	80,443	656,179
Tons of fuel consumed—reporting collieries	Gross tons	2,134,916	458,635	744,371	757,233	4,095,155
Tons of fuel consumed—total	Gross tons	4,173,712	803,137	2,326,259	1,454,029	8,757,137
Gallons of water pumped—reporting collieries	Gallons per year	66,367,723,000	11,151,744,000	17,869,990,000	16,020,442,000	111,409,899,000
Gallons of water pumped—estimated whole field	Gallons per year	116,945,000,000	18,524,000,000	34,327,000,000	26,349,000,000	196,145,000,000
Tons of water	Gross tons	246,803,000	44,471,000	64,453,000	59,576,000	415,303,000
Tons of water pumped—estimated whole field	Gross tons	435,000,000	67,900,000	127,300,000	90,000,000	720,200,000
Average lift	Feet	395	451	516	650	458
Tons of water times lift—reporting collieries	Foot-tons (annual)	171,825,000,000	30,442,900,000	65,686,800,000	58,500,000,000	326,454,700,000
Tons of water pumped per ton coal produced	Tons	10.8	11.5	12.7	9.2	10.9

(a) This includes all coal, fuel, sold to local consumers, and shipped.

The above table shows 16,354,676,000 tons of coal estimated to remain in the anthracite region. On the basis of present day recoveries it may be estimated that 8,979,474,000 tons of this are recoverable. The basis of this estimate is shown in the following table:

Coal remaining in the anthracite fields.

Field	Total coal remaining	Per cent recoverable	Recoverable coal remaining
	Tons		Tons
Northern	3,276,763,000	67	2,195,431,000
Eastern Middle	248,628,000	69.4	172,548,000
Western Middle	3,573,025,000	58.1	2,075,928,000
Southern	9,256,260,000	49	4,535,567,000
Total	16,354,676,000		8,979,474,000

This recoverable tonnage may be separated into that portion recoverable within the next 40 years designated as available, and the reserves, the mining of which will doubtless be deferred beyond 40 years.

	Tons
Available recoverable tonnage	3,907,900,000
Reserves, recoverable tonnage	5,071,600,000
Total, recoverable tonnage	8,979,500,000

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